UNIVERSITY OF QUEENSLAND

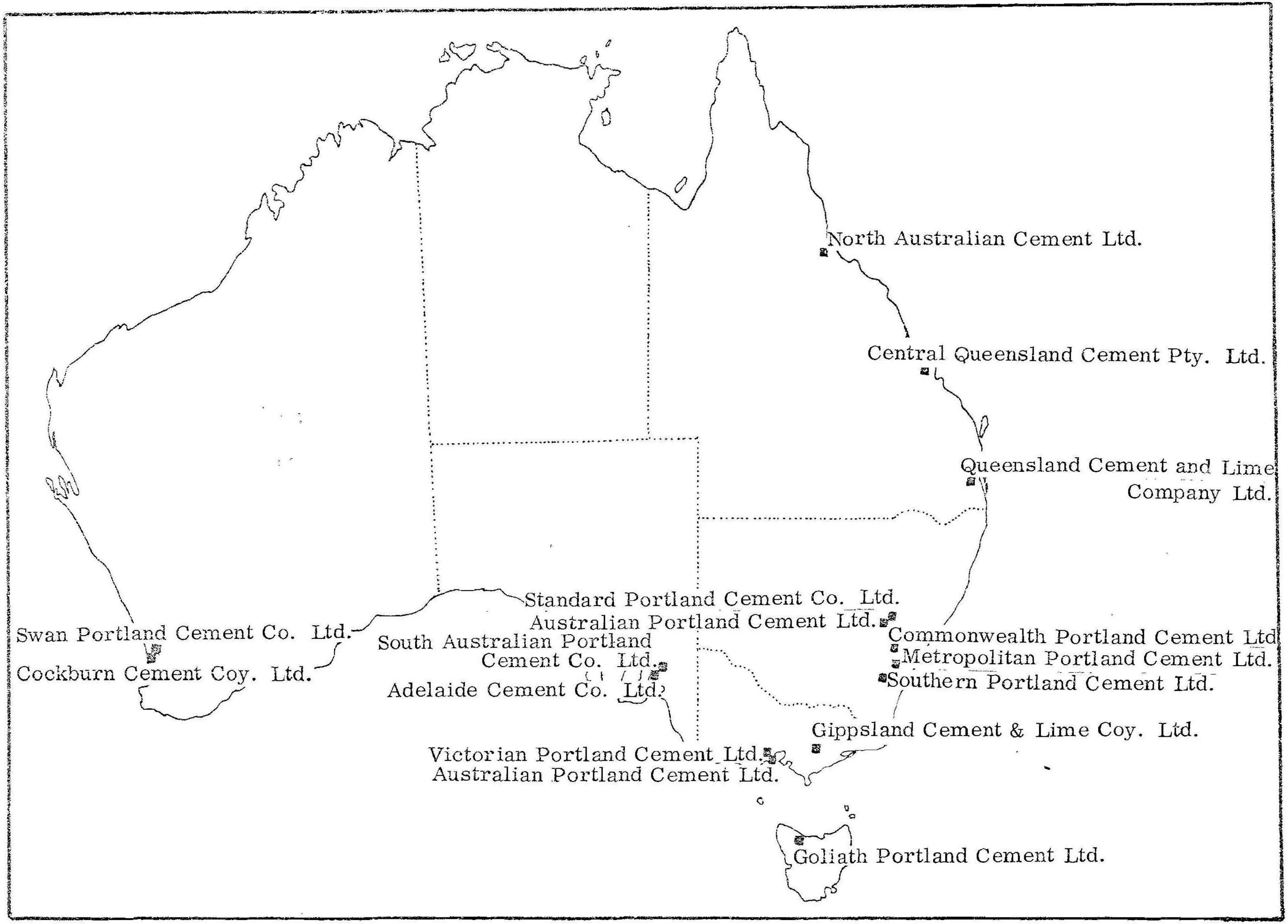
LIBRARY

The persons whose signatures appear below have consulted this thesis by ....McLARREN.................... and are aware that it is available for study only and that no quotations, or substantive information not otherwise available, may be published therefrom without the consent of the author.

NAME	DATE	NAME	DATE
C. Hatton	10.4.75.		
[illegible]	3.6.75		
[illegible]	7.6.77		
J Bennett	10/11.81		
[illegible]	1.10.84		
B. Britton	23-5-85		
Peter Elliot	4-10-88		

Until .... this thesis can be consulted by persons other than staff and students of the University of Queensland only with the written consent of the author.

AUSTRALIAN CEMENT PLANTS, 1967



THE LOCATION OF CEMENT PLANTS IN QUEENSLAND

A STUDY OF MARKET ORIENTATION

by

IAN McLAREN

THESIS

Submitted for the degree of

MASTER OF ARTS

in

GEOGRAPHY

University of Queensland

1970.

P R E F A C E

"The geographer is primarily concerned with what exists on the ground now, and what now exists on the ground in the kind, amount, layout and functioning of industry is the result of innumerable past decisions on where to locate particular works. It follows that satisfactory analysis of the present distribution of industrial activity can be made by the geographer only if he understands what guided the industrialists in making those decisions."

R.C.Estall and R.O.Buchanan,
Industrial Activity and Economic Geography.

The study presented here developed out of an assignment undertaken as part of a course in economic geography. The assignment involved making a case study of an industrial plant and the plant chosen was the Darra works of the Queensland Cement and Lime Company.

This case study and the brief survey of geographic literature which provided background for the study brought to the fore two points. First, the importance of portland cement to our modern civilization can hardly be overstated as it is the most important non-metallic construction material. Second, geographic literature seemed to have little to say about portland cement. An article by F. Lukerman, to which reference is made several times in the following pages, affirmed the above observations and prompted further investigation of the locational aspects of the cement industry in this State. As the location analysis proceeded and the importance of marketing considerations became obvious so also did the complexity of the apparently simple concept, market orientation.

It is possible to distinguish two types of industrial location studies: Those concerned with the description of actual locations and those concerned with the prescription of optimum locations. W.Rawstron in distinguishing these said the former were concerned with reality and the explanation of existing spatial patterns, while the second were concerned with ideal locations, the equilibrium distribution of plants and the attainment of that illusory goal, maximum profits. Each of these may be approached at different levels: at the level of an individual firm, at a broader industry level studying a group of producers who form a meaningful aggregate for analysis, or at a regional level studying the variety of producers associated by their location. Obviously there are links between these distinct types and levels of study and it is possible to proceed from one to another but it is important to recognize the different purpose and nature of each of them.

This study belongs to the first type distinguished and has been conducted at the level of the individual firms to attempt to show why these plants are located where they are today. The investigation had to find the reasons for the original location decisions and the reasons why the oldest plant had persisted in its location. Two aspects of the nature of the study then follow. Such a type and level of study will of necessity involve qualitative assessments of the value and importance of location factors, at least to the extent that the original location decision must have been a qualitative judgment. The most objective tests devised for assessment of profitability will still be subjective in the value they ascribe to various factors and subjective even in the factors they choose to select or reject for objective, quantitative analysis. The second point is that such a study can not of itself provide a framework of concepts and generalizations applicable in a wide range of situations. Such concepts can be obtained only from *a priori* reasoning on evidence collected in this and other ways. Such studies can be of use in building up a body of empirical knowledge but their full value can be realized only if these facts are measured up against the body of theory of the discipline and are used to extend it where possible.

In this study it is intended to establish the facts about the factors involved in, and the reasons for, the locations of the cement plants in Queensland. Equally as important as these facts are the conclusions that may be drawn from them. The first of these are the generalizations about the location decision which allow us to say why these plants occupy these positions; the second are the conclusions used to clarify topics or concepts from the body of principles of economic geography. By far the most important of the concepts investigated is that of market orientation.

I am most grateful to Dr. Craig Duncan for several years of instruction in economic geography and for his interest and enthusiasm which helped to start this project. I must also thank Professor R. H. Greenwood for his help in bringing this study to its final form and for his patience in seeing it to its long overdue conclusion.

Grateful acknowledgment must also be made to several other people whose assistance has been most welcome. The interest and co-operation of officers of the companies concerned was much appreciated and here I must make special mention of the help given by the late Mr. L. J. Jones, Managing Director of the Queensland Cement and Lime Company. Others who helped were Messrs. G. Walker and R. McNamee of the Queensland Cement and Lime Company, Messrs. L.R.Davies-Graham, W.M.Besser and F.Aylmer of North Australian Cement Limited and Mr. R. Pitkeithley of Central Queensland Cement Pty. Ltd. I must also express my appreciation for the help given by Mr. West and the staff of the Statistician's Office and Mr. Nally of The Commercial Manager's Section of the Queensland Government Railways.

Acknowledgment is also made to Mr. Arch.Fraley for the photograph on page 193, to the State Public Relations Department for that on page 162 and to the Queensland Cement and Lime Company for that on page 203.

Finally I must also record my thanks to Mrs. Betty Collins for the many hours she has spent in typing the various drafts of this thesis.

I. McL.

CONTENTS

Chapter			Page
I	AIMS AND METHODS		1
	1.	The Problem	1
	2.	Scope of this study	5
	3.	Statement of thesis	6
	4.	Outline of procedure to validate thesis	8
	5.	Derivation of the thesis	10
	6.	Application of the thesis	23
II	THE NEED FOR THE STUDY		27
	1.	Portland cement and its importance	27
	2.	Divergent statements on locational factors for the cement industry	33
III	THEORETICAL FRAMEWORK (1): SOME CONCEPTS OF INDUSTRIAL LOCATION STUDIES		45
	1.	The theory of plant location	45
	2.	Market orientation	57
IV	THEORETICAL FRAMEWORK (2): MARKETING AND THE CEMENT INDUSTRY		74
	1.	Cement production and marketing	74
	2.	Scale economies and market size	75
	3.	The market for cement	86
	4.	Transport and markets	92
	5.	Main features of the Queensland market	99
	6.	Development of the Queensland market	104

Chapter		Page
V	THE ESTABLISHMENT OF THE INDUSTRY	113
	1. Prior market conditions	113
	2. The first plant	118
	3. The location decision	120
	4. Evaluation of locational factors - a company statement	143
	5. Summary and conclusions	144
VI	THE DEVELOPMENT OF THE INDUSTRY	146
	1. Changing market conditions	146
	2. Expansion of production at Darra	147
	3. Suitability of Darra for the continued supply of the market	156
VII	GEOGRAPHIC DIVERSIFICATION WITHIN THE CEMENT INDUSTRY	173
	1. Growth of new market conditions	173
	2. The need for increased capacity	175
	3. The location decision for the new plant	178
	4. The establishment and development of the Stuart plant	188
	5. Establishment of the Parkhurst plant, Rockhampton	195
VIII	THE TRANSPORT OF CEMENT	208
	1. Rail transfer of cement	208
	2. Division of the market	218
IX	SUMMARY AND CONCLUSIONS	234
	1. The present situation: the producers and the market they serve	234
	2. Features of the location decision in Queensland	239
	3. Market Orientation	246
	4. Conclusion	253

SELECT BIBLIOGRAPHY

APPENDICES

A1 Brief extracts from articles and reports dated 1913 and 1914 by Mr. B. Dunstan, Queensland Government Geologist.

A2 Limestone deposits in South-east Queensland.

A3 Extracts from reports on cement tariffs.

A4 Rail transfer of cement.

A5 Calculation of transport inputs.

MAPS and DIAGRAMS

Figure		Page
	Australian cement plants, 1967	frontispiece
1	Regional price levels and demands	12
2	Cost curves and demand levels	14
3	Transport costs of materials and product	17
4	Transport costs with realistic freight structures and alternative sources of supply	19
5	Factors affecting the regional distribution of markets	100
6	Queensland cement supply	105
7	Queensland cement imports 1900-1914	113
8	Flow sheet	125
9	Location factors in 1914	130
10	Site factors in 1914	138
11	The location of the Darra plant	167
12	The site of the Darra plant	168
13	The location of the Stuart plant	184
14	The site of the Stuart plant	189
15	The location of the Parkhurst plant	198
16	The site of the Parkhurst plant	202
17	Cement prices and distances from cement works	220
18	Queensland cement prices, June 1966.	222
19	Queensland cement prices, 1953 and 1966	223
20	Production at Darra and consignments by rail	228
21	Apparent consumption of cement in Queensland 1965-66	232
	Diagram of distances from Maryborough	A1(iv)
	Rail transfer of cement, 1963-64	A4(v)
	Flow diagram, 1963-64	A4(vi)
	Rail transfer of cement, 1964-65	A4(vii)
	Flow diagram, 1964-65	A4(viii)
	Rail transfer of cement, 1965-66	A4(ix)
	Flow diagram, 1965-66	A4(x)
	Transport inputs for locations between Gore and Brisbane	A5(iv)

T A B L E S

		Page
1	Analysis of a typical portland cement	30
2	World cement production	31
3	Regional distribution of cement sales	106
4	Regional distribution of population in Queensland	107
5	Rail freight rates in 1914	127
6	Consignments from Darra	159
7	Australian production and imports of cement	172
8	Cement sales in North Queensland, 1949-50	180
9	Rail freight rates in 1948	182
10	Government purchases of cement in North Queensland	192
11	Cement consumption in Central Queensland 1960-61	205
12	Tonnages carried and revenue earned from cement and other goods	216
13	Consignments from Darra	227
	Limestone analyses	A2(iv)

* * * * *

P H O T O G R A P H S

	Page
Cement using industries	109
Coral dredging and transport	152
Queensland Cement and Lime Coy. works at Darra	162
North Australian Cement Ltd. works at Stuart	193
Central Queensland Cement Pty.Ltd. works at Parkhurst	203

* * * * *

CHAPTER I

AIMS AND METHODS

"Pronouncements on the locational character of the cement industry are not lacking in geographical literature ... However there is no concensus: no one seems to know exactly what the conditions of cement production are, nor, why the industry is located where it is."

F. Lukerman, "The Geography of Cement?"

1. THE PROBLEM

Lukerman's statement contains a direct challenge to geographers interested in the field of industrial location. Here is a widespread industry of considerable economic importance about which no definite statements can be made concerning the location of plants. And yet this is an industry in which there are only a limited number of quite large plants. The challenge should not be ignored.

Lukerman's small provocative article also contains challenges to all interested in geographic research and its methodology. He discusses briefly a range of broad, conflicting statements that geographers have made on this subject. He makes no reference to his own writings on this subject but a map accompanying the article refers to a study of his that was currently appearing in Przeglad Geograficny. Lukerman condemns other studies of cement plant location on three grounds: the inadequacy of empirical support, in which regard these analytical conclusions were less efficient as descriptions of reality than idiographic description; their use of cartography as a technique of visual aid only; and their failure to recognize the human variable in economic decisions. He further condemns the methodology of these studies because "Without exception, the maps which accompany these studies are not used as inventories of empirical evidence upon which geographic hypotheses are built; rather they are used as illustrations of the <u>a priori</u> consequences of the economics from which the original hypotheses were derived." [1] It need hardly be mentioned that in his own article in <u>Przeglad Geograficny</u>, a series of eight large maps and a series of smaller ones form a quite detailed inventory of facts about the distribution of cement plants in North America over a period of some eighty years. Despite this wealth of factual information there is no simple statement about the locational character of the industry. Because of the degree of generalization that was necessary to present his cartographic inventories it is by no means certain that he had managed to collect the <u>right</u> empirical evidence.

Despite Lukerman's failure to provide what was lacking in the literature his challenge remains.

---

[1] F.Lukerman, "The <u>Geography</u> of Cement?", <u>Professional Geographer</u>, Vol.XII, No.4, July 1960, p.5.

An attempt is made in this study to take an initial step towards solving the problem Lukerman has raised. His article makes clear his opinion that what is lacking is empirical evidence, and this study attempts detailed investigation of a limited number of plants to obtain definitive evidence in a specific set of circumstances. However the other guidelines for future investigation which are implied in his criticisms of previous studies are not followed. He suggests detailed cartographic inventories are essential starting points for studies. This ignores his own point that "The most critical problem here is undoubtedly the selection, measurement and recording of geographic data"[2] Selection implies criteria for selection, and measurement implies definition; both imply theories or hypotheses in existence before the start of the study. Further he suggests that hypotheses be built upon the empirical evidence and not held as a priori consequences of a set of economic preconceptions. Again his own words can be quoted against him for he knows better than this. "Explanation in science is never explanation of observed reality but only explanation of the consequences of hypotheses .... & (explanation in science) has been limited to deductive processes. Theories are generally considered to be a set of laws deductively connected. Hypotheses and axioms, the postulates of theories, on the other hand, are empirical laws, i.e. inductive generalizations, hence not proven."[3]

---

[2]F.Lukerman, "Toward a More Geographic Economic Geography", Professional Geographer, Vol.X,1958,p.10.

[3]ibid, pp.5-7.

Finally, he says "In a study such as geography, professing to be an empirical science, evidence should be given that the necessary consequences of hypotheses conform with observation."[4]

In this study the hypothesis to explain the observed facts will be stated clearly at the outset. Its derivation from economic theory together with those restricting assumptions required for the case being investigated will be shown. The case studies will then be presented to show the correspondence between the hypothesis and the observed facts.

It is realized from the outset that this study may be criticized for its narrowness of focus and for the attempt to base generalizations on a limited number of cases. However the complexity of the problem makes a study in depth essential, and the depth of study required in this initial step precludes greater breadth of treatment. On the other hand, it can be demonstrated that the opposite technique of making generalizations based on a less detailed examination of a large number of cases has been quite unsuccessful in studies of this subject in the past. It is felt that this method, which is to be seen as an initial step only, is the most useful way of proceeding with some certainty to a satisfactory set of generalizations about the industry. If a further apology is needed for the appearance of

---

[4]ibid, p.7.

yet another case study it can be in Professor Lundberg's words, "The one good thing about this kind of survey is that it may upset some of the over-simplified assumptions underlying our usual models."[5]

This study then will attempt to solve the local problem of explaining the location of cement plants in Queensland, to give some lead to the solution of the general problem of the locational character of the cement industry, and to clarify ideas about certain basic general concepts, the most important of which in this case has been found to be the concept of market orientation.

2. SCOPE OF THIS STUDY

This study attempts to describe the location of cement plants in Queensland and to demonstrate the manner in which the main location factor influences the location decision. An analysis has been made of the location factors which were of importance in the locational decisions made at the time of the establishment of the cement plants in Queensland, and those factors which were involved in subsequent decisions to expand production or to establish new plants. Thus both the initial establishment aspect and the continued survival aspect of location analysis have been included.

---

[5] E. Lundberg, "The Profitability of Investment", Economic Journal, Dec. 1959, p. 676.

An attempt has also been made to distinguish between factors relevant to the location decision at the general regional level and those relevant to the choice of a particular site. The conclusions presented relate to both the location of the Queensland cement plants and to market orientation as it has been seen to operate in the cases studied.

The period under investigation has been from the beginning of this century to July 1967.

3. STATEMENT OF THESIS

It is proposed to demonstrate in this study the over-riding importance of the market factor in the location of the cement industry of Queensland. No specific claim is made for the general application of the findings of this investigation in other situations. However the thesis can be adequately substantiated as an explanation of the locational character of the Queensland cement industry and it seems that there is a fair measure of coincidence with the situation in other areas.

Briefly, it has been observed that the industry is primarily market oriented and, at the regional level, this fact broadly determines situation. The location of the plant then depends upon accessibility to raw materials and fuel. Site requirements are not excessively demanding and the exact site is chosen upon the availability of a suitable area of ground with clay and water supplies and transport facilities.

It is proposed to argue that:

(i) The establishment and development of the Queensland cement industry has been consequent on the establishment of an adequate level of local market demand, the actual level required being a function of the prevailing market price.

(ii) Lowest cost access to markets has been the major locational factor in the establishment and development of the industry. The bulky, low value and perishable nature of the commodity is responsible for this attempt to minimize transport costs to the market. The structure of Queensland's rail freight rates, with their *ad valorem* basis and high terminal block charge, gave definite form to this attempt to minimize transport costs. The predominantly urban use of cement and the economies available from location near a major urban centre have reinforced the attraction of large urban markets. Further reinforcement has come from the desire for the monopolistic control of a market by location at the major focus of that market. The market orientation outlined here has operated at the choice of situation level only.

(iii) On the other hand, the economies due to large scale production have, until recently, prevented a geographic diversification of cement plants in Queensland and these plants are still limited in number and highly selective in location.

(iv) A further locational consideration in the establishment of the various plants has resulted from an attempt to minimize the cost of assembly of raw materials and other inputs - the most critical of the raw materials being the limestone. This allows a more precise definition of the location within the general situation set by the market orientation.

(v) The sites of the plants have been determined by the existence of a suitable area of land with available clays and water supply and with access to both rail and road transport.

4. OUTLINE OF PROCEDURE TO VALIDATE THESIS

The thesis presented here is a model in verbal form, a "simplified structuring of reality which presents significant features or relationships in a generalized form,"[6] a hypothesis attempting to specify relationships between the Queensland cement industry and its environment: in particular the thesis attempts

---

[6] R.J.Chorley & P.Haggett, (eds), Models in Geography, Methuen & Co., 1967. Chapter I, "Models, Paradigms and The New Geography", p.22.

to specify the relationships that are important in understanding the location of these plants.

A model must be able to be tested for internal coherence and for appropriateness, and the thesis stated here will be tested on both counts. First it will be shown how the thesis may be derived from *a priori* assumptions to demonstrate its structural consistency and its relationship to aspects of economic theory. This may be done fairly briefly and the derivation of the thesis occupies the following section of this chapter. Second it will be shown how the propositions of the thesis describe the locational features of the Queensland cement industry. This procedure is a more lengthy one and occupies Chapters V - VII, but an outline of the sequence of facts needed for substantiation of elements of the thesis is given in the final section of this introductory chapter. Because in the final analysis it is transport charges -- the costs of overcoming spatial friction -- that determine the form of the location decision, Chapter VIII surveys the contemporary scene of the producing plants and the markets they serve through an investigation of the transport of cement in Queensland.

It has been necessary to present also certain background information, some of it related to economic theory and some related to peculiarities of the cement industry or of the Queensland situation. This information is presented in Chapters III and IV, as also are arguments that may best be dealt with there rather than at scattered points later in the study. Chapter II is also background information in that it is a justification for the study -- a brief discussion of the commodity, the production of which is being investigated, and a survey of some of the rather inadequate statements that have been made about the locational character of the industry.

5. DERIVATION OF THE THESIS

The propositions of the thesis stated in Section 3 may be seen as a series of verbal models, not highly generalized but specific to the Queensland scene. In this section it will be shown how these general statements are derived from basic premises of economic theory by applying some restricting assumptions related to the economics of the cement industry and to the fact that the plants are in Queensland. The value of this procedure is that it imposes the need to specify the conditions under which the model operates: that is, to state clearly what are the peculiarities of cement production in Queensland which impose local conditionality on the hypothesis.

Before proceeding to a consideration of the models it is necessary to specify four basic premises on which they rest:-

(1) There are variations in the quality of locations with regard both to endowment and to accessibility;

(2) There exists a set of markets which are hierarchical in form;

(3) Entrepreneurs possess perfect information; and

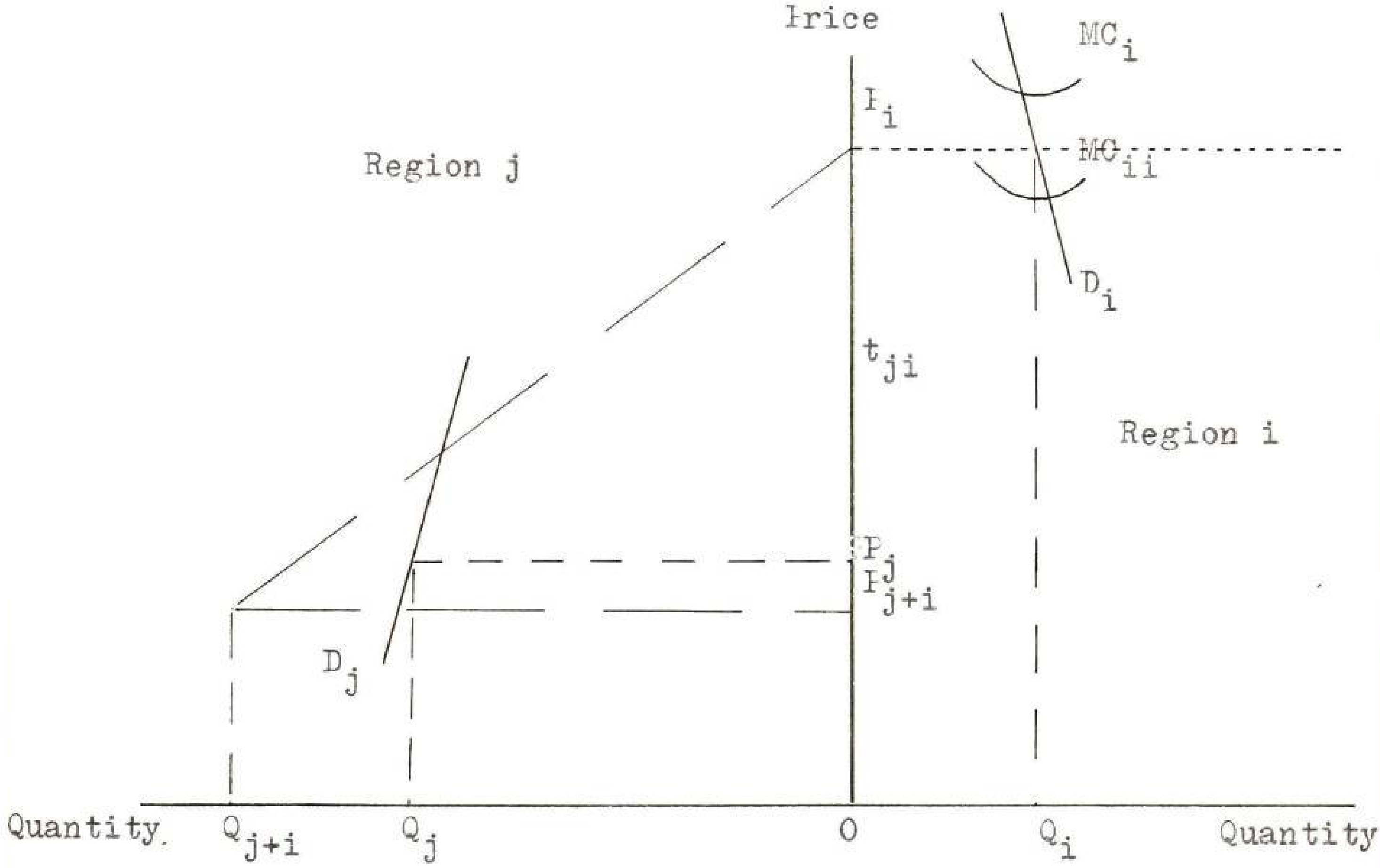
(4) Entrepreneurs will exhibit rational behaviour in decision making.

It is realized that premises (3) and (4) are of doubtful validity but insofar as the entrepreneurs have been successful their knowledge, if not perfect, was at least adequate.

Model 1. The first proposition describes the prior demand conditions for the establishment of a plant in a region supplied from outside. The model is a variation of that used by Samuelson, Orr and Ohlin in an examination of interregional trade.

Consider the case of a region i where there exists a demand for a good but there is no production of that good. Given another region j where there is surplus production of that good, and given the appropriate circumstances of distance and costs of transport, trade occurs to supply the need. The price in region i will be (if there is no "dumping") at least the cost at the place of origin plus transfer charges (all rates and charges including tariffs where applicable and distributors' profits). This means the prevailing price is set in region i and so the level of existing market demand is also set. A plant may be established in region i if the average cost curve for the plant intersects the demand curve at a point below the intersection of the prevailing price and the demand curve. (If the new plant is to use marginal cost pricing instead of average cost pricing then the marginal cost curve may be substituted for the average cost curve).

Fig. 1 Regional price levels and demands, and interregional transfer charges.



P_{j+i} is the price in Region j with production for both regions.

$P_i = P_{j+i} + t_{ji}$, where t_{ji} is amount of transfer charges from Region j to Region i.

Q_i is the quantity sold in Region i, supplied from Region j and sold at P_i under the demand conditions indicated by D_i.

MC_i & MC_{ii} show the marginal costs of two plants with capacities in the range of Q_i. Under the price and demand conditions shown, the plant with marginal costs MC_{ii} could operate successfully; the other could not.

Into the general model we must introduce restricting assumptions: (i) Economies of scale exist in the industry and are the major variable in costs while variations in procurement, production and distribution costs are negligible; and (ii) the plant is to be of a size to serve region i and not to produce for export.

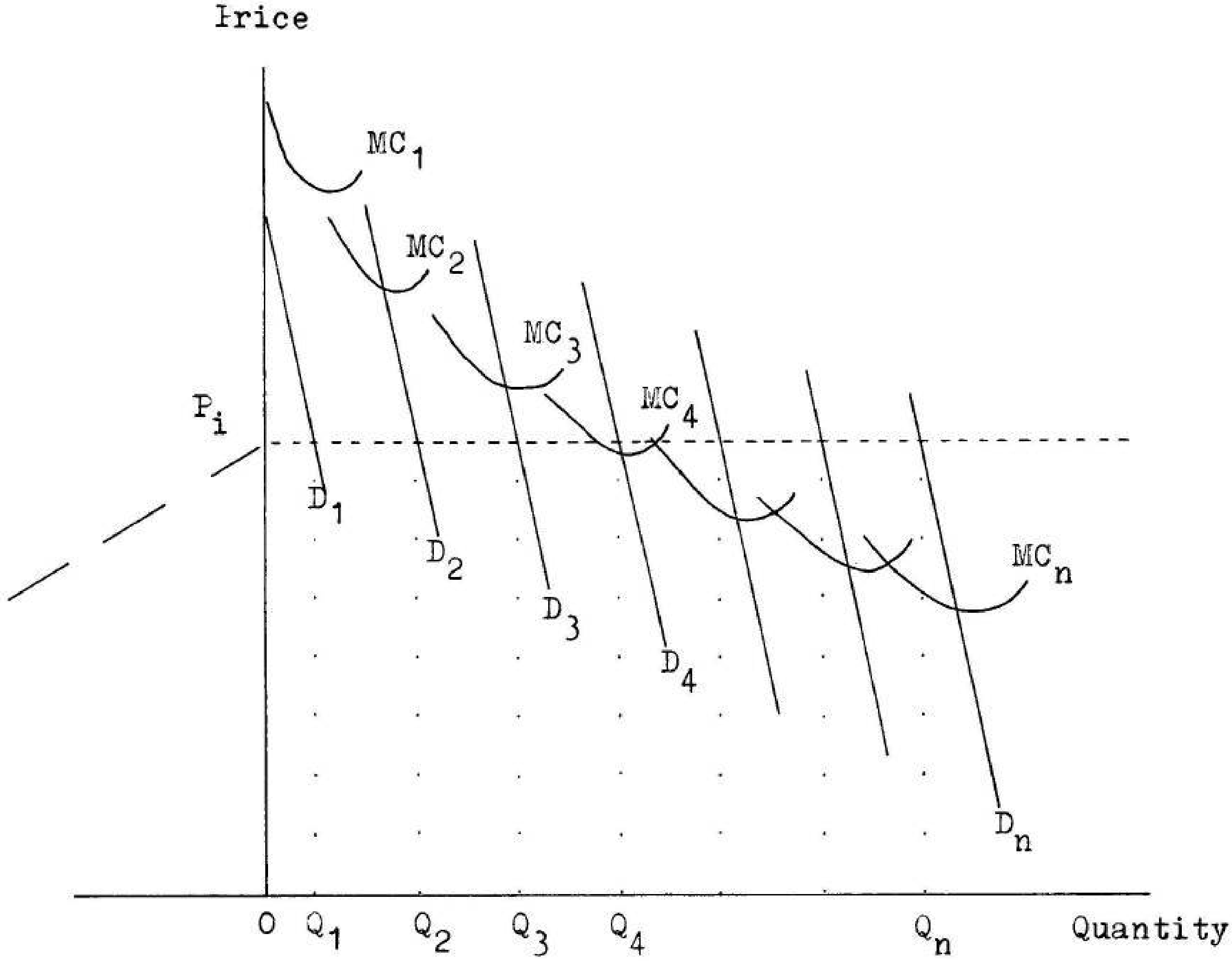
Then if the demand is small only a small scale, high cost plant could be built - and then only if the price was high. If the price was low a larger scale, lower cost plant could operate - and this could be built only if the demand was at an adequate level.

Introduce restricting assumption (iii) Region i has a <u>growing</u> demand for the good.

The establishment of a plant then depends on the growth to an adequate level of the established market demand - the level being that at which the plant could operate and sell at a price below the prevailing price.

(Alternatively this model could have been derived from that used by Hoover to develop the concept of the "margin line" which describes the relationship between delivered price and the extent of a market, or the division of a market between two separated producers. This would not be particularly apt here but could be used in Model 3 below.)

Fig. 2. Cost curves for plants of increasing scale and demand levels of increasing magnitude.



MC_1, MC_2, ... MC_n	:Marginal cost curves for plants of increasing scale.
D_1, D_2, ... D_n	:Demand curves at successive points of time in a growing market.
P_i	:Prevailing regional price set by outside supply.

At price P_i and demand conditions D_2, quantity Q_2 is sold. A plant could not operate successfully to supply only Q_2 but plants could operate successfully to supply Q_4 ....Q_n.

<u>Model 2</u>. The second proposition describes the general situation of the plant and in doing so makes three statements: first, the location is a cost-minimizing solution arrived at by seeking proximity to market because of high transport charges; second, other considerations reinforce this decision; and third, the location choice at this level is not of a single point but of an area.

The first statement considers a least-cost solution and as such it may be regarded as a version of the Weber model. This operates under the special conditions that:

(i) the location and size of the places of consumption are given;

(ii) the location of raw material deposit is given; and

(iii) the geographic cost pattern of labour is given, and that at any point labour is unlimited in supply at constant cost.

Restrictions (i) and (ii) are quite suitable but restriction (iii) need not be applied rigorously. In view of the modest labour requirements of a cement plant and Queensland labour market conditions, (iii) may be changed to read "at any point labour is adequate in supply at constant cost."

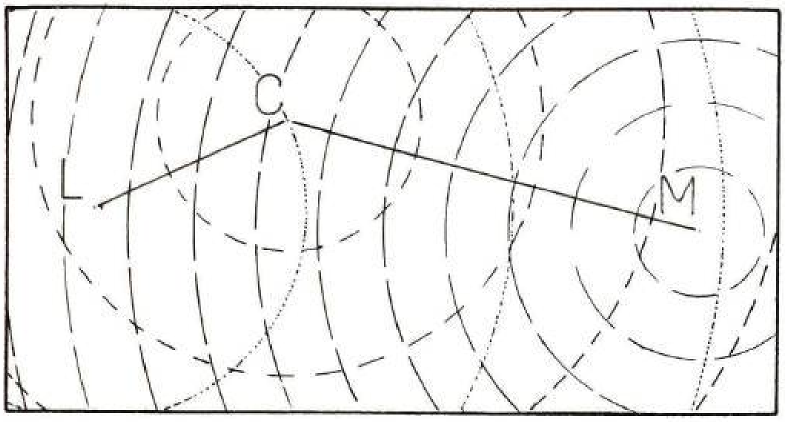
The Weber model states that entrepreneurs will locate plants at points of least cost in response to transport, labour or agglomeration factors. If labour and agglomeration factors are held constant the model resolves to a least-transport-cost model. The plant will then be located at the point where the combined costs of raw material assembly and product distribution is least.

Introduce the restricting assumption of a product which is very expensive to transport - partly because of its own nature but also because of the ad valorem basis of the freight rates. Let it be more expensive to move one unit of product over a given distance than to move the raw material equivalent over the same distance. The market is then the point of lowest transport cost and the plant will locate there. In other words, the location will be chosen to provide lowest cost access to the market as this is the choice which will provide the lowest total transport costs.

The next statement is that there are other economies that accrue at the near market location. Relax the restrictions on variability in labour costs and agglomeration economies but specify that the benefits from these factors are greatest at the market centre. These influences reinforce the decision and further reinforcement comes from the competitive tactics adopted by the firm. The arguments for this contention will not be given in full here but will be regarded as established by Greenhut's minimax model which shows that uncertainty as to opponents' tactics under conditions of oligopolistic competition in undifferentiated products leads to location where it is assumed, or known, that rivals can achieve optimum sales at lowest cost.

Fig.3. The level of transport costs of raw material assembly and product distribution at various locations.

3a.



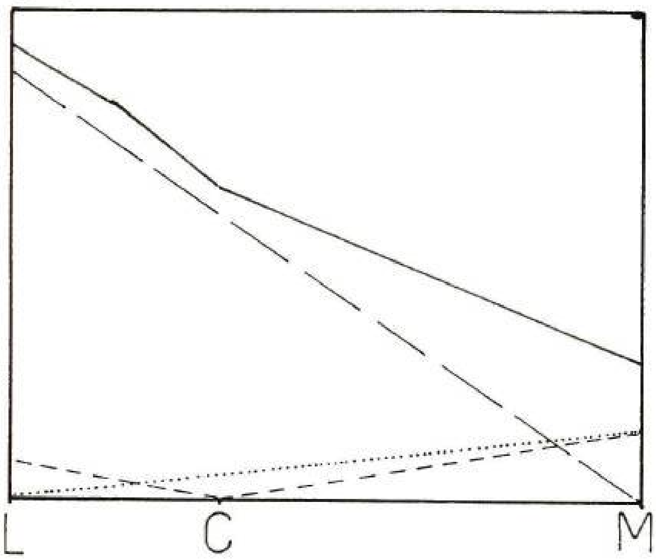
L. C. Sources of raw materials L & C

M. Market

Transport route

Isotims (after Hoover: isopleths of equal transport costs of raw materials or product)

3b.



Then at any point along LCM:

- - - - - Cost of transporting raw material C

.... Cost of transporting raw material L

— — Cost of transporting product to M

——— Total transport costs on L, C and product to market.

If finally we introduce the realistic restrictions that freight rates have terminal block charges and that location exactly at the actual end point is impossible, there is no determinable point set by an end-point solution. As in reality, instead of an absolute minimum-cost point there is indeterminacy among sites having near-minimum costs within the terminal zone. This partly explains the third statement that the solution is an areal one.

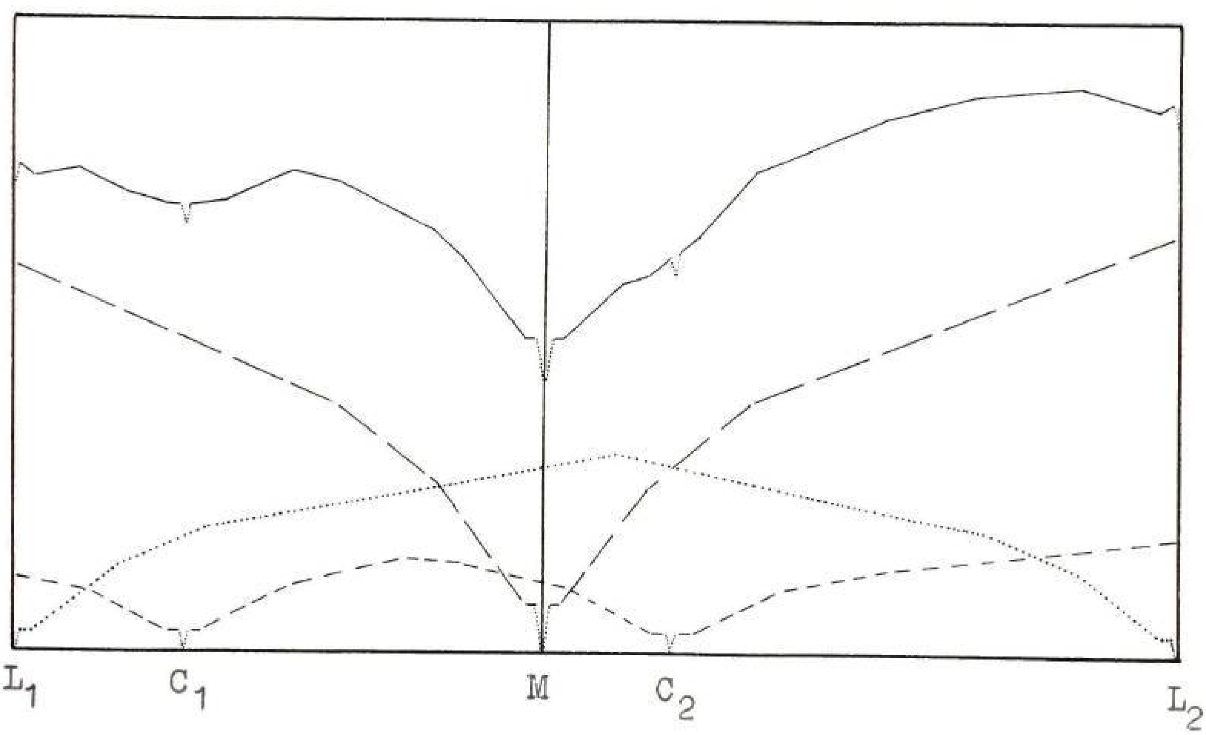
This, though valid, is inadequate as an explanation of the statement because there are more important reasons for the near market solution being an areal-, not a point-, solution. However this is as far as progress can be made on a Weber model. If we wish to consider other than a punctiform centre of consumption we need to incorporate elements of Loschian models which envisage the more realistic conditions of market areas and of maximum-profit motives. If we recognize that markets are areal, that they constitute a set and are hierarchical in form then progress can be made.

The total market for a good in a region, to be called here the regional market, is only one of a set of such regional markets. The regional market is itself a set of sub-regional markets which are not of the same size but can be ranked in hierarchical order. If this is recognized then the above model could be reformulated to incorporate this greater approximation to reality. The third statement of the proposition could be derived more satisfactorily but the arguments for statements one and two would be more unwieldy.

Fig.4. Transport costs with realistic freight structures and alternative sources of supply.

L_1 & L_2, C_1 & C_2 are alternative possible sources for the raw materials and are connected by a single transport line through M.
Realistic freight rates apply:

(1) discriminating between commodities,
(2) being less than proportional to distance,
(3) having terminal block charges.



Then at any point along L_1ML_2:

- - - - - - Cost of transporting raw material C

.... Cost of transporting raw material L

— — Cost of transporting product to M

——— Total transport costs on L, C and product to market.

However we can apply these concepts to the conclusions drawn from the simpler model. The first statement could be modified in this way to give a more accurate statement of the situation of the plants. Location to provide lowest cost access to the regional market requires location to minimize the costs of reaching the larger sub-regional markets where these constitute a major part of the total market. Where the spatial arrangement of demand is focal in character (as is the almost universal arrangement of all aspects of geography associated with human occupance) then "lowest cost access to market" is replaced by "lowest cost access to the major sub-regional market which is the focus of demand for the whole regional market."

In the second statement, instead of the unmeaningful restriction that the reinforcing benefits are somehow attributes of the market, we have the realistic condition that labour and agglomeration benefits are greatest in the focus that is the major sub-regional market. The tactical reason for location can be extended to include the realistic tendency to locate so as to tap the largest sales potential within the market area. And finally the need to explain the area around the market centre merely as a terminal zone is removed since the major subregional market actually is an area.

<u>Model 3</u>. The third proposition explains the limited number of plants in a large areal market despite the primary market orientation of these plants by the existence of economies of scale. In all essentials the model is the same as Model I above with the total regional market being seen as a set of markets. However in this proposition there is also a statement of the relative importance of the economies due to large scale production and the economies in transport costs due to a near market location.

In Model I was the restricting assumption that economies of scale were the major variable in the production cost of the good. This needs to be extended in this model to specify that they are a major variable in the delivered price of the good, the other major variable being the transport cost. From the model we could then deduce that one of three equality conditions could prevail. The first would be when the economies of scale were equal to the diseconomies of a long haul of product. The case is indeterminate and need detain us no further. The second would be when the economies of scale were greater than the diseconomies of a long haul, which diseconomies promote market orientation. Under these conditions in some sub-regional market the price would be too low to allow a small-scale plant to operate if it were designed for the demand in that small market. The third case would be when the economies of scale were not greater than the diseconomies of a long haul. Under these circumstances a smaller-scale plant could be established in a distant sub-regional market where the price was high.

This is an extension of the first proposition stressing the interdependence of markets and prices and the place of transport costs in determining prices. A plant will be built when demand reaches an adequate level, the actual level being a function of the prevailing price, and this price in turn being a function of both the transport costs and the scale of the plant previously providing the good.

Model 4. The fourth proposition describes how, within the general restraints imposed by the situation requirements, the location choice is narrowed to locations which will minimize transport costs on the raw materials. This is a further but specialized application of a Weberian model where, under restraints, a least-cost location must be found depending on the relative weights and locations of the raw materials. The raw materials which are regarded as ubiquities may be ignored in this analysis.

Introduce the restricting assumption that there are only two raw materials and that one of them has in Weberian terms a locational pull five times that of the other. The minimum-cost location will then be where transport costs on the heaviest raw material are least.

Model 5. The final proposition specifies site requirements. The point should be made here that in Weberian theory materials are usually classified as "Ubiquitous" or "Sporadic" in occurrence. Some requirements may be regarded as ubiquities when deciding situation by choosing between sub-regions, in that these requirements are available in all of the sub-regions. However at the level of choice of site they may not be equally available everywhere and so at this level they enter directly into the analysis. But it is stressed that they must be considered at the choice of situation level before they are set aside as ubiquities.

There is no general model here unless it is in those aspects of the modified Weberian model which specify that the more ubiquitous materials are least considered and that the reduction to zero of the transport costs of some material is preferable to having to move it at all. The site requirements stated in this proposition are all restricting assumptions describing requirements peculiar to the cement industry.

6. APPLICATION OF THE THESIS

In substantiating elements of the thesis by demonstrating their applicability to the facts of the case study, the following sequence will be adopted: first, to consider conditions leading to the establishment of the industry and the location problem of the first plant; second, to consider how changing conditions affected the viability of the plant in that location; third, to consider the locational factors which were operative in the recent period of geographic diversification of the industry; and fourth, to examine for the contemporary scene the transport of cement from the three plants and the division of the market between them.

Before proceding to this chronological sequence it is necessary to present certain facts that are relevant in each step of the study, and further to consider features in which changes occurred throughout the whole period of the study. In particular it is necessary to consider aspects of the industry related to the economics of the production and marketing of cement and significant in a location study. This involves a consideration of factors which would operate to cause, on the one hand, concentration of production in one large scale plant or, on the other hand, dispersal of production among a larger number of smaller plants. It will be recognized that there is a basic antithesis between the desire to achieve the economies of large scale production and the desire to minimize distribution costs by locating plants close to widely distributed customers. This general discussion of the nature of cement production and marketing is followed by a more detailed discussion of these points in the Queensland case. Of particular importance here are the changes in the Queensland market over the period of the study and the relationship between transport and markets.

The first stage in the development of the Queensland cement industry was the establishment of the Queensland Cement and Lime Company's plant at Darra. The growth of the Queensland market to a size that warranted the establishment of this plant will first be investigated. The production factors - the sources and relative importance of the raw materials, and the other input factors of fuel and power, labour and capital - will then be analysed to ascertain their relative importance in the original location decision. The suitability of the Darra site and location will then be evaluated in the light of these location factors and the reasons given by the company for this choice. It is to be noted that this study is attempting to show why the company built at Darra and not attempting to prove that the site at Darra was the optimum site for a plant in Queensland.

During the subsequent years productive capacity at the Darra plant was continually expanded. At first this was compelled by the need to seek economies of scale and permitted by the excess of market demand over local supplies, but later expansions indicate that the plant continued to be viable at this site. During this period there were many changes in the nature, magnitude and extent of the market and changes in the production factors. These latter changes involved a radical reorganization of the raw material supply situation. The importance of these changed factor supplies will be analysed to evaluate the continued suitability of the site to serve the Queensland market.

Although expansion continued at Darra after 1948, by this time it was obvious that a new set of conditions had developed which required geographical diversification of production rather than increase of production at the established site. The North Queensland market had grown to such a size that it warranted the establishment of a new cement plant. The motives for the establishment of this plant, the market conditions and transport costs of the period will be analysed to establish the locational factors involved in this decision to install the new productive capacity at Stuart rather than at Darra. The substitution problem was between additional outlays on transport and reduced outlays on production due to economies of scale for the Darra plant on the one hand and additional outlays on production and reduced outlays on transport for the proposed Stuart plant on the other. The impact of the locational factors involved here and the effects of governmental and social pressures and incentives will be analysed. A similar situation arose some years later in respect of the central Queensland market and a similar analysis of conditions in this case also will be made. With three plants operating to supply Queensland's cement needs the division of the market between them is then discussed.

Finally an attempt will be made to collate the locational factors revealed as significant by these analyses, and to demonstrate that the stated thesis can be substantiated as an explanation of the locational character of the Queensland cement industry.

CHAPTER II

THE NEED FOR THE STUDY.

1. PORTLAND CEMENT AND ITS IMPORTANCE

Since man first started to build, he has endeavoured to find a material that would bind sand and stones into a solid formed mass. In the ancient riverine civilizations of the Assyrians and Babylonians, clay was used for this purpose. The Egyptians discovered that lime and gypsum could be used as cementing agents to bind bricks and blocks of stone. The Romans, over two thousand years ago, manufactured a cement by mixing slaked lime with volcanic ash and the efficacy of this cement is demonstrated by the fact that certain of the buildings, bridges and aqueducts constructed with this material are still standing today.

Lime cements continued to be the main type of cements until the Industrial Revolution. In 1756 John Smeaton, while engaged on the construction of the Eddystone Lighthouse, noted that the best hydraulic limes were those made from limestone with an appreciable clay content. However it was not until 1796 that Parker in producing "Roman cement" heated the raw materials to just short of vitrifying temperature. Frost in 1822 produced his "British cement" and Aspdin in 1824 produced the first so-called "Portland cement", but both of these could be better described as hydraulic limes since the raw materials were heated only to calcine the limestone and not to clinkering temperature. The name was given to the cement because of the resemblance of the set product to a natural stone quarried at Portland, England. However the modern portland cement is rather different from that which Aspdin first made. About 1845, I.C.Johnson "produced a cement of the modern portland cement type by burning the raw materials 'with unusually strong heat until the mass was nearly vitrified', and this clinker when finely ground made a cement which was far in advance of the ordinary type produced at that time."[1] Since then the main advances in cement production have been in the introduction of new machinery for the transporting, crushing, pulverizing and burning of the raw materials, and in the chemical control of the constituent elements to utilize a wider range of raw materials and to produce a range of varieties of the basic type of portland cement. Since the beginning of this century portland cements have been the principal cementing material used in construction although some use is still made of cements having similar properties such as natural cement and blast furnace slag cements

---

[1]F.M. Lea and J. Desch, The Chemistry of Cement and Concrete, E. Arnold, London, 1956, p.108.

or pozzolan cements.[2]

Portland cement is made today by burning a mixture of calcareous and argillaceous materials to clinkering temperature and grinding the resultant clinker. The mixture may be a natural one or an artificial one using limestone, chalk or coral for the calcareous material and clay or shale for the argillaceous material. After the clinker has been ground, gypsum (calcium sulphate) is added to act as a retarder to prevent the too rapid setting of the cement. The resulting cement is then composed of the oxides of calcium, silicon, aluminium, iron and sulphur plus minor amounts of other impurities (See Table 1).

---

[2]Pozzolan cement is usually a mixture of slaked lime and granulated blast furnace slag. The name is derived from Pozzuoli in Italy from whence volcanic ash, variously called pozzolana, pozzuolana or puzzolan was obtained for hydraulic cements. Some pozzolan cements are made from similar volcanic ash occurring elsewhere. (see p. 194.)

Natural cement is made by burning a marl known as cement rock which has satisfactory proportions of the necessary chemical ingredients for the production of a cementing material. By contrast, in the production of a portland cement, greater attention is given to the exactness of the proportions of the ingredient elements.

TABLE 1

a. Analysis of a Typical Portland Cement

(After Lea & Desch)

Lime	CaO	64%
Silica	SiO_2	23%
Alumina	Al_2O_3	4.5%
Iron Oxide	Fe_2O_3	3.1%
Sulphuric Anhydride	SO_3	2.4%
Other	-	3.1%

b. Suggested Composition

$4CaO.Al_2O_3.Fe_2O_3$ 9.5%	$3CaO.SiO_2$....42%
$3CaO.Al_2O_3$ 6.7%	$2CaO.SiO_2$....34%

Portland cement is a generic name for a number of varieties which are made by varying the proportions of the main ingredients. Each variety possesses qualities which suit it for some special use. The High Early-Strength portland cements have a higher than usual tri-calcium silicate content and are more finely ground. These have, as well as the property of rapid hardening, a greater resistance to the action of sea water and better refractory properties, but the disadvantage of a higher heat of hydration which makes them unsuitable for use in large mass concrete structures such as dams. High alumina cements possess similar properties. Low heat cements were first developed for use in the Hoover Dam and have low tricalcium silicate and low tricalcium aluminate proportions. The other main variety of portland cement is Sulphate resisting cement which has a higher than normal proportion of both silicate fractions. Special cements such as white and other coloured masonry cements are not strictly portland cements, and as they are not produced in Australia do not merit fuller description.

The word cement, when used in this study, refers to portland cement unless otherwise specified. This is sanctioned by common usage where the word, particularly if it is unqualified and used in connection with building and engineering, refers generally to portland cement. This usage stresses the fact that portland cement is the most important cement used at the present time, the world's output amounting to over four hundred and thirty million tons per annum. Of this total Australia produces over three and one half million tons per annum. (See Table 2).

TABLE 2

WORLD CEMENT PRODUCTION

(from United Nations' Statistical Yearbook, 1966, Table 125, p.298)

	Metric Tons
World Production	433,000,000
U.S.S.R.	72,388,000
U.S.A.	65,078,000
West Germany	34,133,000
Japan	32,689,000
France	22,411,000
Italy	20,234,000
United Kingdom	17,025,000
China	11,000,000
India	10,578,000

Most of the cement is used in making concrete which occupies a dominant position in modern construction. Concrete consists of a paste of water and cement binding inert aggregates (sand, gravel or crushed rock), into a rocklike mass as the paste hardens through a chemical reaction of the cement with water. Concrete is used in urban construction, in building highways, bridges and dams, in irrigation, water supply and sewage facilities, in airport runways, docks and harbours and in a variety of other projects. As well as this primary use in concrete construction, cement is also used in "cement products" most of which are in turn used in construction. Some of the more important of these are concrete masonry, cast stone and concrete pipes and asbestos cement sheeting and shapes.[3] Cement consumption is in fact a useful indicator of activity in the construction industry and, because of this, a useful indicator of economic activity as a whole in a modern industrialized economy. Modern cement production requires a large investment in capital equipment and the plants making cement are invariably large scale units. The industry as a whole is widespread throughout the world but production is markedly concentrated in the countries which are more advanced industrially. Production figures for the

---

[3] Probably 20% of the cement produced annually in Australia is now used in "asbestos cement goods" and "other cement goods." If "ready mixed concrete" is included with "asbestos cement goods" and "other cement goods" as it is in Commonwealth statistical publications, then these bulk consumers now use almost 60% of the cement produced annually in Australia. (Manufacturing Industries, 1965-66, No.1, Cement and Cement goods, Bureau of Census and Statistics).

world and for the leading producing nations have been given in Table 2. Of the total annual production the United States and the U.S.S.R. each produce about 16 per cent, Japan and West Germany each produce about 8 per cent and Italy and France each about 5 per cent. Altogether over fifteen countries produce more than 1 per cent of the world total, but of these, the leading four countries together produce 50 per cent of the total, and approximately 75 per cent of world production is concentrated in Europe and North America. Australia produces just under 1 per cent of the world total.

2. DIVERGENT STATEMENTS ON LOCATIONAL FACTORS FOR THE CEMENT INDUSTRY.

As has been pointed out, the cement industry is one in which the volume of production is quite large: in fact the weight of cement produced each year is approximately equal to the weight of steel produced and is greater than the production of all the metals other than iron together. The industry produces one of the most important of constructional materials, and, because of this, is a valuable indicator of economic activity. Moreover, as it is an industry which has emerged since the Industrial Revolution, it is one in which technological advances have been extremely important. Although the industry is widespread it does, because of the nature of the product, exhibit sharp localizations. These features would seem to indicate that the industry deserves rather more attention from economic geographers than it has received in the past.

However the industry receives only scant attention in many geography texts and other studies of economic activity. When such references as can be found are investigated further, it is noted that there are marked differences of opinion on the reasons for the location of the cement plants. In Lukerman's words "Pronouncements on the locational character of the cement industry are not lacking in geographical literature. Because of the industry's widespread distribution in both pioneer and advanced societies, and in industrial and non-industrial economies, most surveys in economic geography contain comment on the production pattern of cement as to its occurrence and areal relationships. However there is no concensus: no one seems to know exactly what the conditions of cement production are, nor why the industry is located where it is."[4] Lukerman illustrates this contention by quoting from five economic geography texts, divergent statements on the locational character of the industry. Reference to these and other texts reveals that the pronouncements on the locational character of the cement industry are even less prevalent and even less adequate than Lukerman suggests. Such reference however affirms Lukerman's contention that there is no concensus of opinion.

---

[4] F.Lukerman, "The Geography of Cement?", Professional Geographer, Vol.XII, No.4, July 1960, p.1. In this article Lukerman has attempted only to draw attention to the problem, to collate opinions and "reformulate the original geographic questions which provoked such a diversity of opinion". No attempt is made to provide definitive answers. Apparently very little attempt has been made by other geographers to provide answers to the questions that he has raised.

On the matter of the nature of sources consulted Lukerman says: "some readers may argue that textbooks are the last place to look for answers to questions, but the student who searches elsewhere will find even less consolation." (p.3)

Very few texts give an unqualified statement that one locational factor alone is dominant, but most of the texts state that two or more factors are of importance. However contradictions between statements in various texts were noted. Only one text attempted to distinguish between location factors influencing choice of situation and those influencing choice of site, yet this fundamental scale distinction must be made clearly if the whole discussion of location factors is to have any meaning.

The types of orientation which were given most prominence were orientation to raw materials, to markets and to transport facilities although Lukerman[5] also notes certain historical factors. Capital and labour requirements were not stressed though the immobility of fixed capital in plant can be subsumed in the above mentioned historical factors. No reference was found which distinguished between factors involved in the decision on the original location of the plant and those factors which ensured the longer term viability of the plant (unless a reference to the adequacy of the size of the original limestone deposit can be counted as such). No mention was made of taxation, land costs or wages as locational factors and no indication was given as to the reason for this omission: either they are only a small part of the total product cost or they may be assumed to be areally undifferentiated. Energy requirements and costs were mentioned in only one of the texts investigated.

---

[5] ibid, pp.4-5.

Raw material orientation was mentioned in most of the references and, in at least three texts, the statement of raw material orientation was unqualified: i.e. raw material requirements were stated to be the dominant locational factor. The bulk and weight of the raw materials to be used and their low value were the main reasons given for their importance in the location decision. All of these references were, by nature of their excessive simplification, unsatisfactory. More satisfactory references distinguishing between the raw materials, the relative amounts required and the costs of these, and their relative ubiquity or scarceness were rarer.

The simplest, and least satisfactory, theories of raw material orientation are demonstrated by the following statements :

(i) "Owing to the bulky nature of the raw materials, cement manufacturing plants are commonly located near the source of their raw material and not necessarily within the market area."[6]

(ii) "Since the raw materials are of heavy weight in proportion to value, cement factories tend to be localized."[7]

(iii) "Since limestone is the most important constituent of cement, cement plants are located usually where a plentiful supply of limestone is available."[8]

---

[6] C.F.Jones & G.G.Darkenwald, Economic Geography, MacMillan, New York, 1954, p.330.

[7] N.A.Bengston & W.Van Royen, Fundamentals of Economic Geography, Prentice Hall, New York, 1956, p.340.

[8] S.E.Ekblaw & D.J.D.Malkerne, Economic and Social Geography, McGraw Hill, New York, 1958, p.314.

A far more satisfactory discussion of the role of raw material considerations in the choice of the site of the plant is given by E. Willard Miller whose discussion of the factors involved was probably the most satisfactory of those referred to.

(iv) "Of the raw materials limestone exerts the greatest influence on cement plant location. Clay or shale is usually available in most localities and even if they are not available locally only about one-third as much clay or shale as limestone is needed. Coal normally moves toward the limestone because much less coal is needed than limestone and coal deposits are more geographically restricted. Although deposits of limestone are widely distributed not all are suitable for cement manufacture. A cement limestone cannot contain more than about 10% magnesium carbonate or improper ratios of aluminium, silica and iron oxide, or excessive impurities such as silica, iron pyrite or sulphur. Other factors to be considered in regard to limestone are the size of the deposits (to assure several years of operation), the method of mining that can be employed and especially the location of the deposit in relation to convenient transportation lines and the cement market."[9]

[9] E. Willard Miller, A Geography of Manufacturing, Prentice Hall, Englewood Cliffs, N.J., 1957, p.426.

Opposed to the direct unqualified statement of raw material orientation, as presented in references (i), (ii) and (iii) above, is the following direct statement of market orientation which argues the near-ubiquity of suitable raw materials and fuel:

(v) "Fortunately limestone and clay (or shale) are to be found in every State. There are few areas where at least one fuel - coal, oil or gas - cannot be obtained for industrial use. Therefore cement plants are located close to the market, the distribution of plants roughly coinciding with the distribution of population."[10]

The following quotation illustrates the unresolved conflict between these assessments of orientation:

(vi) "Proximity or lowest cost access to markets is the major location factor for cement plants since the heavy, bulky and low value product cannot stand the cost of expensive haulage. In addition plants must be strategic for the assembly of raw materials and fuel which may be coal, oil or natural gas. The most critical raw material is the limestone which must contain less than 3 per cent magnesia - a stipulation that excludes many lime rock deposits. Consequently cement plants are generally located either near the markets or adjacent to a major limestone quarry."[11]

---

[10] J.R.Smith, M.O.Phillips and T.R.Smith, Industrial and Commercial Geography, Holt, N.Y. 1955, p.427.

[11] R.M.Highsmith and J.G.Jensen, Geography of Commodity Production, J.B.Lippencott, Chicago, 1958, p.353.

The following quotation also illustrates the same conflict but does little to resolve it as it evades the issue by referring to the "ideal location". However it does mention the importance of economies of scale (though it does not examine the full implication of these economies) and the importance of a low cost route of transfer.

(vii) "Because of the low value of cement in relation to weight, because it is made from heavy raw materials, and because considerable fuel is used, not much can be shipped far from the factory unless the plant is on or very near navigable water. Hence it is one of the most widely distributed of all industries. Moreover since cement is produced most profitably on a large scale, the distribution of cement mills is proportionate to the distribution of population. The ideal location is one where raw materials and fuel are in close proximity both to one another and to a large market. Some such locations do exist."[12]

The following quotation further exemplifies the conflict between the different orientations but, although inconclusive in its treatment of the relative importance of different factors, there is at least <u>some</u> attempt to rank the factors.

(viii) "The distribution of cement mills is roughly proportionate to the distribution of population ... the factors having the greatest influence on the location of cement mills are

---

[12] G.T.Renner, L.Durand, C.Langdon & W.B.Gibson, <u>World Economic Geography</u>, Crowell, New York, 1957, p.488.

the relative position of raw materials and the market. Though the fuel consumption is quite large and represents a considerable portion of the cost of manufacturing, there are few, if any, areas in the United States where at least one of the fuels, coal oil or gas, cannot be obtained. Cement has a low value per unit of weight and nearness to market is of paramount importance. Outward transport expense, on an average, accounts for 16.5% of every dollar of net sales. When we consider the raw materials however we find that a cement mill must be located at the source. The widespread distribution of limestone together with the widespread supply of fuel has permitted the location of cement mills with primary consideration being given to the market."[13]

As indicated above probably the most satisfactory discussion of the factors involved is that by E.Willard Miller, who points out the differing effects of these factors on <u>situation</u> and <u>site</u> decisions.

(ix) "Cement is a cheap heavy commodity, manufactured from bulky raw materials and using considerable fuel. It can be produced profitably only on a fairly large scale. Consequently the ideal location for a cement plant is one where supplies of raw materials and fuel are found in close proximity to each other

---

[13] E.B.Aldefer and H.E.Michl, <u>Economics of American Industry</u>, 3rd Edition, McGraw Hill Book Coy, New York, 1957, p.184.

and to a large market. Thus, ideally, the sites of the plants are raw material oriented and the regional location of plants is market oriented."[14]

The importance of market orientation is given further stress in the following statement:

(x) "However since about 1920 there has been a tendency to locate plants in regard to their market areas with the availability of raw materials playing a relatively secondary role. Many large plants are now constructed on the outskirts of cities. This has been especially desirable where navigable waterways give cheap transportation to distant raw materials. The large urban area not only provides a market for cement, but a convenient assembly point for raw materials."[15]

It will be noted that although the references quoted have dealt with raw materials and fuel, markets and transportation, no mention has been made of ancillary power requirements. Only Miller made reference to the importance of the use of electric power which is used in cement works chiefly for driving ancillary equipment especially in the grinding of the raw materials, coal and clinker. Perhaps in the United States

---

[14] E. Willard Miller, A Geography of Manufacturing, Prentice Hall, Englewood Cliffs, N.J., 1957, p.426

[15] ibid, p.426

the availability of power and power cost differentials are such that omission of a discussion of power costs is excusable, but this is certainly not the case in Queensland. Miller states that:

(xi) "Since the economics of production favour plant location close to markets, it is evident that cement mills will have widely differing energy costs, depending on the level of fuel costs in each region."[16]

The passages that have been quoted here serve to illustrate the divergence of opinion in standard texts. To attempt to explain this divergence is a useful exercise which reveals so much about this subject on which a wide range of geographers have made such conflicting statements. The exercise brings to the fore three facts.

1. Distinction must be made between locational factors operative in <u>site</u> determination and those setting the regional <u>situation</u>. These two terms "site" and "situation" are used in this essay as a <u>precise</u> and a <u>general</u> description of location respectively, in accordance with the usage of the terms commonly found in geographic writings. By site is meant the exact position of the plant with regard to the precise features, both physical and man-made, of the local environment. By situation is meant the location of the plant in the wider regional setting.

---

16 ibid, p.427

2. Likewise distinction must be made between factors which are involved in an original location decision and those which ensure the long term viability of the plant.[17]

3. Great caution must be exercised by the geographer wishing to make a general statement on the locational character of an industry if the situation that is apparent in this case is to be avoided. The statements quoted above tend to emphasize indiscriminately certain relevant factors. They therefore are not incorrect statements but partial statements which, although correct in certain contexts, can be completely misleading in other situations.

Further consideration makes apparent the need for case studies in particular contexts of time and place. To be a useful contribution to the body of theory of economic geography such studies must offer general conclusions, but these general statements must be qualified as being applicable only in situations very similar to that described in the case study.

---

[17] For a full discussion of the margins of viability approach to location studies see W.Rawston, "Three Principles of Industrial Location", in Transactions of the Institute of British Geographers, 1958. J.W. Alexander in Economic Geography, Prentice Hall, New Jersey, 1963, pp.351-352 makes a similar distinction between initial and survival location factors, but his survival factors do not encompass changes in the initial factors and adjustments made to compensate for these changes.

At this point it is well to consider Ackerman's contention that the paucity of knowledge in geography at this stage is such that fundamental research must be disaggregative. It is not yet at a stage where the integration of data on processes and site may be considered.[18] The implications of this for the methods of study of economic geography cannot be fully discussed here but it is felt that the research strategy outlined by Ackerman may err on the side of excessive caution. The formulation of generalizations can not wait until all the available data has been compiled. A more satisfactory and practical approach may be that suggested by McCarty.[19] McCarty suggests the formulation of areally-restricted or topically-restricted hypotheses which, if shown to be valid, could then be more generalized as more data became available from other studies to allow the formulation of broad principles of economic geography. Thus the generalizations which may be drawn from the particulars of a case study such as this are of two kinds. On the one hand there are the conclusions about the location decision which may be applicable in other areas. On the other hand there are the amplifications or clarifications of concepts which are used in the study and may then be applied to the investigation of other topics.

---

[18] E.A.Ackerman, "Geography as a fundamental research discipline", University of Chicago, Department of Geography, Research Paper No.53, 1958.

[19] H.H.McCarty, "An Approach to a Theory of Economic Geography", Economic Geography, Vol.30, 1954.

CHAPTER III

THEORETICAL FRAMEWORK (I): SOME CONCEPTS OF INDUSTRIAL LOCATION STUDIES

1. THE THEORY OF PLANT LOCATION

Early writers in the field of plant location theory tended to concentrate on either the revenue side of alternative locations or on the cost side of alternative locations. Although the idea of the least-cost location model originated in the work of Launhardt in the nineteenth century, one of the most influential writers to popularize this approach was Alfred Weber.[1] Predohl,[2] whose contribution is described in the next section, refined some of Weber's work by the application of the Walrasian general equilibrium approach to the site selection process. These models were unrealistic in that they pre-supposed a framework of perfect competition and market demand concentration in a single point consumption place.

In the work of later writers more realistic assumptions of monopolistic competition through site control, of the interdependence of firms within a

---

1. A Weber, Theory of the Location of Industries, tr.by C.J.Friedrich, University of Chicago Press,Chicago, 1929.

2. A.Predohl, "The Theory of Location in its Relation to General Economics", Journal of Political Economy, Vol.XXXVI, 1928, pp.371-90.

multi-market economy, of a regional approach through trade theory and of realistic transport rates replaced the excessively simple notions of earlier models. Some major contributors at this time were Palander[3], Ohlin[4] and Hoover[5] whose works still used the least-cost method of determining locations even though variations in the demand factor were considered. Of particular importance was Hoover's recognition of the realities of transport rates, the fact that rates are usually graduated and less than proportional to distance and that as a result industries tend to locate at end points along transport routes rather than at intermediate locations.[6]

August Losch[7] was the most influential modern writer to popularize the maximum-profit approach by stressing that it was the difference between total

---

[3] Palander's Beitrage Zur Standortstheorie, 1935, is not available in English but his influence on Hoover and Isard is acknowledged by these writers.

[4] B.Ohlin, Interregional and International Trade, Harvard University Press, Cambridge, 1952.

[5] E.M.Hoover, The Location of Economic Activity, McGraw-Hill, New York, 1948.

[6] ibid, Chapters 2-4.

[7] A.Losch, The Economics of Location, tr.by W.H.Woglom, Yale University Press, New Haven, 1954.

costs and total revenues that indicated the firm's optimum site. However, while Losch was able to introduce more realistic assumptions in some aspects of his model, the increase in complexity made it necessary to introduce other simplifying assumptions such as ubiquitous resources and uniform procurement and production costs at all sites.

Developments of Loschian models have been made by some modern writers with more and more realistic assumptions but these have usually been applied to describing conditions of spatial equilibrium of industry rather than to describing procedures of choice at the level of individual plant location. The abstraction from reality has seemed to lead to a cul-de-sac of indeterminacy concerning the location decision. This eventuality was apparently foreseen by Losch who stated "There is no scientific and unequivocal solution for the location of the individual firm, but only a practical one: the test of trial and error. Hence Weber's and all other attempts at a systematic and valid location theory for the individual firm were doomed to failure."[8] Some of the important contributions to this line of investigation have been those of Koopmans and Beckman,[9] Alchian,[10] Tiebout[11] and

---

[8] ibid, p.29

[9] T.Koopmans & M.Beckman,"Assignment Problems and the Location of Economic Activity", Econometrica,Vol.25, Jan.1957.

[10] A.Alchian, "Uncertainty, Evolution & Economic Theory", Journal of Political Economy, Vol.58, June 1950.

[11] C.Tiebout, "Location Theory, Empirical Evidence & Economic Evolution", Papers & Proceedings, Regional Science Association, Vol.3, 1957.

Sakashita.[12] Developments of the Loschian model have apparently reached the stage of being too complex to be applied in practice, the stage that Haggett described as being "too true to be useful".[13]

Concurrently with these developments of Loschian models work has been done which contributes to the formal integration of both the Weberian least-cost and Loschian maximum-profit approaches. Isard[14] has made contributions to this field as have Greenhut[15] and Moses[16], but it is Isard's work that has been most influential in providing the theoretical background to this study. But despite his incorporation of Loschian ideas in his general equilibrium theories Isard has used the Weberian approach for practical studies. Although he recognizes that only under strong limitations is Weberian doctrine generally applicable, he says "Indeed, it is only by utilizing chiefly the Weberian approach with supplementary economic data that I have found it meaningful to analyse the locational structure of the iron

---

[12] N.Sakashita, "Production Function, Demand Function and Location Theory of the Firm", Regional Science Association: Papers, Vol.XX, 1967.

[13] P.Haggett, "Models, Paradigms and the New Geography", Ch.I of Models in Geography, R.J.Chorley and P.Haggett, (eds), Methuen & Co., 1967, p.21.

[14] W.Isard, Location and Space Economy, Technology Press of the Massachusetts Institute of Technology, John Wiley & Sons, New York, 1956.

[15] M.Greenhut, Plant Location in Theory and Practice, University of North Carolina Press, Chapel Hill, 1956

[16] L.Moses, "Location and the Theory of Production", Quarterly Journal of Economics, Vol.72, May 1958.

and steel industry."[17]

However in the integrated approaches to a more realistic if less practical theory Isard, Greenhut and others have produced more complex models that encompass almost all of the known, measurable economic variables. These models also have to admit indeterminacy in their application to individual cases because of the inclusion of the human factor in the equation. Economists have recognized these factors in two main areas but their inability to ascribe monetary values to these factors has led to two different approaches to this aspect of the problem. In one area are the values and goals involved, the cultural, social or personal satisfactions being sought in the location decision. The location decision is still a human decision subject to the prejudices of the entrepreneur and taken within a societal framework that imposes certain restraints or may even dictate the decision. The approach which most clearly recognizes the personal factor is found in the line of enquiry followed by investigators[18] who have sought to establish by case studies or by surveys of industrialists those factors which were most important in location decisions. While few studies along these lines have

[17] W.Isard, op.cit. p.37

[18] These are too numerous to mention individually. The main contributions by geographers have been in this field but interest has been mainly in aggregates of industry rather than in individual cases.

contributed to the body of theory on this subject they have provided valuable evidence for analysis. In the following section the work of T.E.McMillan Jr. is considered in more detail.

The other area in which the human factor has to be considered is the area of competitive business decisions. Once it is recognized that some producers by their actions do affect the level of price and volume of demand for a good then it follows that their actions affect the decisions of competitors. An attempt to resolve such situations of interest conflict has led to the application of game theory to entrepreneurial decisions. This is still far from being a useful practical device for either description or prediction in individual cases. But as in Greenhut's application of game theory to the theory of location under competitive conditions, it has yielded some results. It has been useful in showing the effects of oligopolistic competition with its attendant uncertainty as to competitors' retaliatory reactions to market seeking strategies, particularly in undifferentiated products. In particular it has been useful in establishing a rationale for first, the observed tendency of competitors to cluster and so produce specialization of production in an area, and second, for the observed tactics of operators to locate in market areas where it is thought, or known, that competitors can achieve maximum revenues.

For the reasons outlined on the previous pages most modern authorities on industrial location theory will not claim that location theory can show the firm the path to the optimum location, as they regard "best choice" locations as sub-optimal or "satisficer" locations only.[19] Because of the impossibility, as demonstrated by Tiebout, of distinguishing the maximum-maximorum from neighbourhood maxima, the use of the term "optimum" is perhaps inappropriate. (Tiebout uses "optimal" for "best choice"). Although the term cannot mean the "absolute and indisputable best", it is retained in the literature to mean the "best available under the restraints on the choice". "Optimum Location" is retained in this study because it is the most widely used and accepted term and on pragmatic grounds because "the best that can be chosen" is, for practical purposes, "THE best".

Despite indeterminacy in the general models, in reality patterns of industrial distribution do show remarkable regularities and indisputable signs of order. The geographer is concerned to describe and explain "what exists on the ground <u>now</u>" and, in that firms do try and have tried to choose optimum locations, the

---

[19] F.E.Hamilton, "Models of Industrial Location", pp.362-424 of <u>Models in Geography</u>, R.J.Chorley & P.Haggett, (eds), Methuen & Co., 1967, p.380.

C.Tiebout, "Location Theory, Empirical Evidence & Economic Evolution", <u>Papers and Proceedings</u>, Regional Science Association, Vol.3, 1957.

geographer must be concerned with the theory of optimum locations. However in this concern he must not lose sight of his primary objective which is the comprehending of areal differentiation in reality rather than the formulation of an optimum system. At the level of an individual study such as the one presented here, the geographer must be concerned with the study of industry where it actually is located rather than with the prescription of optimum locations. He may be able to show that a location chosen for a plant was a rational best choice, or that under certain restraints (specification of goals and information available) it was the optimum location that could be chosen. He need not show, indeed he can not prove, that it was <u>the optimum location</u>.

In his attempts to explain elements of the complex patterns discernible in reality the geographer must beware of what Chisholm[20] called the "absolutist" approach - the tendency to explain a fact in terms of other facts with which it is areally associated. As many writers have stressed in this regard, the explanation of industrial patterns must begin with the actual individual location decisions. It is in understanding

---

[20] M.Chisholm, <u>Geography and Economics</u>, G.Bell & Sons, London, 1966. Other quotations in this study that are relevant at this point are the one by R.C.Estall and R.O.Buchanan in the Preface and that by K.L. Wallwork in Chapter IX Section 2.

the factors that enter into a decision and the way in which a decision is made that location theory is most helpful.

The student of industrial location today has an embarrassing richness of location theory to provide him with the concepts, models and methods of approach for the explanation of any problem. The first difficulty is to choose the most useful concepts and models for the type of study undertaken. In offering an explanation for the facts observed in the case study undertaken here, modified Weberian Theory of a least-cost approach to the location decision has been used as it seemed to be the most applicable to the circumstances and also to be the most practical approach.

The first major problem encountered in this study arises from the need to express a distinction not usually made in location theory. The problem arises in what geographers have long recognized as the need to distinguish between <u>situation</u> and <u>site</u> as general and specific descriptions of location, as descriptions of regional and local settings. Both aspects of a location are usually described in <u>geographic</u> literature. Although the concept of this distinction is commonly used there is little theoretical discussion of it.[21]

---

[21] Cited above in footnotes 19 & 20 are three recent works by geographers. Each mentions the distinction and that it is important but has little else to say on the matter. Variations in the terminology employed and variations in the factors considered as situation or as site requirements point up the inadequacies of the theoretical framework. See M.Chisholm, op.cit,pp.36-37,F.E.Hamilton, op.cit,p.367, and K.L.Wallwork,op.cit,p.167

It is recognized that situation and site are not separate features but are mental constructs as convenient distinctions appropriate to the chorographic and topographic scales of study. They are thus two different aspects of a single location. The distinction seems to be more than merely a matter of scale- a derivative of the old problem of the degree of generalization of data appropriate to the scale of the study. If this were the case (as is suggested by Chisholm) the attributes of sites and of situations would be the same attributes treated at different degrees of generalization. Actually completely different attributes are considered at each level. It seems to the present writer that this occurs because of the differing patterns of distribution of different phenomena. Attributes of sites are those phenomena which may be considered as ubiquities when choosing between regions while they have to be recognized as of sporadic occurrence when choosing between sub-regions - the word region being used without any connotation of order of magnitude. Attributes of situations may be conversely defined. Thus it is possible to speak of the situation of a city in a central position on a lowland or of the site of the city at a river junction. Further an industrial plant may be situated in an urban area but sited where it can dispose of effluent.

Situation is then location with respect to the significant phenomena of sporadic occurrence at a regional level while site is location with respect to the significant phenomena of sporadic occurrence at a subregional level. It follows that the situation of some feature is a first approximation to a description of its location while its site is an exact definition within the bounds of the first approximation.

In the study undertaken here it was found necessary to move towards the definition of plant location by an approximating or a centripetal approach through a general definition of the situation of the plant to a precise definition of its site.

In location theory however, location is regarded as more precisely definable: in calculations it is a point and movement towards it follows a direct path - even when using such a sophisticated form of analysis as linear programming. There is no applicable multi-level, approximating approach although in the application of substitution analysis to Weberian theory as outlined by Isard "involving spatial substitution in the large and small"[22] this distinction could perhaps be possible. Something like the situation-site distinction occurs in the isodapane technique of Palander and Hoover which recognizes that a trough occurs in the cost-surface on which the isodapanes are "contours" of the level of costs. Within this trough a low point

---

[22] W. Isard, Location and Space Economy, Technology Press of the Massachusetts Institute of Technology, John Wiley & Sons, New York, 1956, p.94.

can be distinguished. The isodapane technique is prohibitively cumbersome to apply but in an investigation of reality, where there are finite transport lines instead of a transport surface, some simplification is possible and allows its use in cases such as in this study.

Thus although Location theory offers no multi-level approximating approach to definition of a location, this seems to be the practical approach by the entrepreneur. (See in the next section T.E.McMillan Jr. for his discussion of regions with the pre-requisites for production and sites with the determinants of location.)

The second problem in this study arises from the lack in economic theory of a dynamic model to explain location with changing conditions. Neither has it been possible to devise a single model encompassing spatial and temporal variations. The thesis being argued is a series of static models in which changes through time can occur but in which time is not an explicit dimension. In this study the technique adopted has been :-

(a) to isolate that sector of the topic in which changes with time are most important and to present that sector separately to show the main changes over the period. This is done in the next chapter on marketing;

(b) to present the facts of the case study chronologically. This involves treating the location decision for each plant separately; and

(c) to present a survey of the contemporary scene investigating the movement of cement to the markets of the State. This is done in chapter VIII.

2. MARKET ORIENTATION

Over the years during which this case study was conducted one basic concept which needed elucidation recurred continually. This was the concept of market orientation which is of fundamental importance to this study and, as a general principle in many fields of economic activity, it is probably the single most important concept encountered during the investigation. So much of the argument of this thesis depends on an accurate comprehension of this little understood concept that it was felt essential to include a basic discussion of it as part of the theoretical framework of the study. No other concept of equivalent difficulty occurred in the study or warranted such treatment.

In at least five of the texts quoted in the previous chapter it is recognized, or it may be inferred, that the market may act as a location factor for industry. Isard attributes to Launhardt the presentation of "the first significant treatment of industrial location theory"[23] in the 1880's and points out the distinction he made between serving a one-point

[23] W. Isard, Location and Space-Economy, Technology Press of the Massachusetts Institute of Technology, John Wiley & Sons, New York, 1956, p.143

consumption place or an areal market. "Weber treated only the first of these problems ... the later writing of Palander, Hoover and Losch are much more satisfactory in this respect."[24] Of these the works of Hoover and Losch are the most easily accessible and have had the greatest impact on the work of American geographers. The above economists all regard the market as having a locational attraction for some manufacturing plants. American geographers from R.Hartshorne[25] in 1927 to J. W. Alexander[26] in 1964 and English geographers from S. H. Beaver[27] in 1934 to R. C. Estall and R.O.Buchanan[28] in 1961 all include the market in their classification of factors in the location decision.

---

[24] ibid, p.143

[25] R.Hartshorne, "Location as a factor in Geography", Annals of the Association of American Geographers, Vol.XVII, March 1927, pp.92-99.

[26] J.W.Alexander, Economic Geography, Prentice-Hall, Englewood Cliffs, N.J. 1964.

[27] S.H.Beaver, "The Localization of Industry", Geography, Vol.20, 1935, p.191

[28] R.C.Estall and R.O.Buchanan, Industrial Activity & Economic Geography, Hutchinson, London, 1961

The importance of market orientation to this study makes it essential to investigate the nature of the attraction of a market and the way in which it acts as a locating factor. At the intuitive level it is obvious that goods have to be sold after their manufacture and that the costs of distribution will be lessened by location close to the customers. On the other hand it is intuitively obvious that proximity to sources of the required raw materials will lessen assembly costs prior to manufacture. It has been the practice following Weber to consider that the location of a factory is determined by the extent to which the raw materials experience a loss of weight during the manufacturing process. Some geographers have spent considerable time and ingenuity contriving indices to express relationships between the weights of raw materials and of product,[29] but while such calculations ignore the realities of freight rate structures they can be of little use. It is obvious that freight rates with an _ad valorem_ basis charging a lower rate per ton for raw materials than for manufactured goods make it possible to shift larger amounts of raw materials than of manufactured goods for the same outlay. The existence of such a freight rate structure was of fundamental importance in the case studied here.

In simple terms, industries will seek to locate close to their markets to minimize the high freight charges which would result when there is an increase in bulk or weight during the process of manufacture, or when the processing creates a more delicate, fragile or

---

[29] W. Smith, "The Location of Industry", _Transactions of the Institute of British Geographers,_ 1955.

perishable product. In cement manufacture there is no increase in weight or bulk during manufacture; there is in fact a loss of weight equal to about one-third of the weight of the raw materials alone or about three-fifths of the total weight of raw materials and coal. The cement is however a bulky, low-value commodity and at this point it would be wise to dismiss the widely held but ill-founded belief that goods of high value are better able to stand the costs of transport. This belief underlies the statement from G.T.Renner *et al.* in the previous section. "Because of the low value of cement in relation to weight .. not much can be shipped far from the factory."[30] It is given expression also by R.C.Estall and R.O.Buchanan when, in citing examples of market orientation, they give as one class those industries producing cheap commodities, e.g. cement, because "Transport costs will add less proportionately to the cost of materials of higher value."[31] A little thought makes it apparent that the ability to sustain transport costs is not the price of the good but the *margin* between the price and the production cost, the gross profit.[32]

---

[30] G.T.Renner, L.Durand, C.Langdon & W.B.Gibson, *World Economic Geography*, Crowell, New York, 1957, p.488.

[31] R.C.Estall and R.O.Buchanan, *Industrial Activity and Economic Geography*, Hutchinson, London, 1961. See Chapter II "Materials, markets and transfer costs" particularly Part B, "The influence of markets."

[32] See Chapter 5 of A.Losch *The Economics of Location* tr. by W.Woglom, Yale University Press, New Haven, 1954. Losch presents a rigorous mathematical examination of Thunen's theory and concludes "The sequence of spatial order is often explained plausibly and on a commonsense basis, even by Thunen, by saying that the 'lighter' or the 'dearer' good is produced farther out, because with it freight is less important. This vague statement can be false .. Transportability does not depend on value".

Of more significance than weight changes during manufacture is the fact that the final product is more perishable than the raw materials. This adds to distribution costs because, as well as the higher freight rate for the finished product, there are extra costs involved in protection from the weather and terminal costs related to handling.

Another group of industries for which a location close to market is desirable are those undertakings whose products are subject to rapid change in style, design, technological character or popular interest. These factors are not of importance in the cement industry.

In the discussion so far the usage of the term "market" has not been inconsistent with the simplified concept of a single point consumption place. In this connection the term "nearness to market" simply means proximity to some point where a demand for the good exists. If we introduce the more realistic concept of an areal market with variations in the intensity of demand, then market orientation can be more realistically presented as lowest cost access to the market.

When a very large part of the demand is concentrated in one portion of the market area that portion becomes the most attractive location whether or not it provides lowest cost access to the total market. This happens because the manufacturer does not make his

---

Losch shows it to depend on "the gross profit per unit of product" (the difference between the price and the outlay) which is the highest freight charge it is possible to pay.

decisions on plant location as a public service having in mind the greatest good of the greatest number. He is interested in having the lowest delivered cost in a market to ensure an outlet for his products in the face of competitive sources of supply. In the terminology of games theory he is involved in a non-zero game that is not strictly determined and he adopts as his optimum strategy not the maximizing of his payoff but the minimizing of his chances of loss. As a result, in a market area with substantial differentiation in intensity of demand, market orientation becomes lowest cost access to the major part of the market. (See later discussion on the nature of the competition involved). When the strong focus of demand in a region is a large city then the attractiveness of location close to this market concentration is reinforced by the other economies that can accompany any urban or near-urban situation -- availability of existing transport, water supply and power facilities, access to a large labour pool, access to service and ancillary industries and to financial and commercial institutions.

Not all economists would agree that markets are <u>determinants</u> of plant location. This line of analysis began with Weber who postulated that the location and size of places of consumption were fixed, and then determined industrial location in terms of the supply and location of raw materials and labour: in the extreme case Weber implied that transportation costs were the sole determinants of industrial orientation. In a more recent study T.E.McMillan gives this type of partial analysis a new and practical expression by setting some factors aside as pre-requisites.

"If an industry is resource oriented, it must place prime importance on raw materials. If the manufactured product embodies high labour costs or highly skilled labour, labour market conditions -- occupy a position of prime importance. No plant can justify its existence without a place to sell its output, therefore markets must rank high. But these are not determinants of a particular location. Instead they are pre-requisites to operation. Transportation may also fall into this category of pre-requisites."

"The problem of determinants of location is thus resolved to general geographic regions which provide the basic pre-requisites. Depending upon the market area to be served, this general region may be as small as a single county or as large as several states. The plant locator has no choice in placing the plant in the proper region - a region which provides the basic pre-requisites. He does have a choice as to where he places the plant within this region. This is where determinants of plant location enter the scene; this is where alternate choices have to be weighed against each other. When this is done such items as taxes, business and political climate, low priced land, room for expansion, economic construction costs and other such variables become the real determinants".[33]

[33] T.E.McMillan,Jr. "Why Manufacturers Choose Plant Locations versus Determinants of Plant Locations." Land Economics, Vol.41, 1965, pp 239-246. McMillan in this article analyses the results of a McGraw-Hill Plant-site survey among subscribers to "Business Week".

In this discussion McMillan has not removed market considerations from the location decision; instead he has made a location decision at two levels. This is in accord with the point made at the end of the previous section: the location decision involves a choice of situation and a choice of site and quite different location factors operate to determine each of these. McMillan's discussion thus stresses the importance of the market as a factor in the location decision at the level of determination of the situation of a plant.

The discussion of market orientation so far

(a) has indicated which circumstances cause the market to be attractive as a location for certain industries,

(b) has shown that this attraction is exerted through variations in freight and associated charges, and,

(c) has shown that it operates at the choice of situation level.

The discussion has not considered the market as one of an array of factors in the location decision nor has it indicated any way in which the location decision can be made. The most useful course to follow in order to place these factors in perspective, to place them in the context of orthodox production theory and to offer a means of solving the location problem, is the course suggested by W. Isard.[34]

[34] W. Isard, Location and Space-Economy, Technology Press of the Massachusetts Institute of Technology, John Wiley & Sons, New York, 1956.

For Isard the location problem was part of the total production problem which he saw as involving not only the production problem of the traditional one-point economy but also spatial variations in the availability, mobility and cost of commodities (embracing factor services). To solve this problem Isard has taken Predohl's basic idea of using "the familiar substitution principle already well established in general equilibrium theory"[35], and has developed it by the use of the transport input concept. This is a weight-distance unit which can be considered beside capital, labour and other industry inputs. A cost (the transport rate) may be attached to these transport inputs so that costs of various inputs may be compared together with the value of outputs. The production problem becomes a problem of choosing the right combination of the various types of capital, labour, land and transport inputs. The problem is solved by substitutions among alternate combinations of costs and output revenues until nett profits are maximized. Note that the location problem is solved not necessarily by minimizing transport inputs but by solving the production problem as a whole. This does not mean that the whole problem must be solved at once by simultaneous solution of all the production and location variables. If there are significant differences in the level of variation of different variables it may be possible to solve the whole problem merely by finding the appropriate level for one major variable. In this way location at, say,

---

[35] ibid, p.32

a cheap power site may, for some industrial plant, incur higher than the minimum transport inputs yet may be far more profitable than location at the point of minimum transport inputs. Alternatively, location near a large urban centre may provide sufficient external economies to compensate for additional transport inputs so that the total cost of production is less than at the point of minimum transport inputs.

There is no need to adopt an extreme Weberian position and to maintain that transport costs are the sole determinants of location but it should be recognized that transfer charges are the ultimate locating factors in the choice of alternative positions in a spatial economy. Certainly a plant requiring large amounts of power may locate at a cheap power source but it can do so only if the transport costs on raw materials and product to and from that site do not raise total costs above a competitive level.

In the previous section it was indicated that economists have found the maximum-profit motive to be a more satisfactory explanation of economic behaviour than the minimum-cost motive. Nett revenues depend on the levels of prices, outlays and output of the plant. A firm determines nett revenue potentials for alternative locations and selects that location yielding the maximum nett revenues provided that the conditions of normal competition apply. Under these conditions where the necessary restrictions apply the cost-mininizing motive can be the active part of the profit maximizing motive. Under conditions of normal competition and where the volume of sales and the price is set, if we can assume rational behaviour, the plant operator will seek to minimize costs. The minimizing of transport costs must be seen as only one aspect of this process. The others are the minimizing of the prices of inputs, which the small individual producer probably can not control, and the use of the most efficient combination of inputs in the production process. We must then further modify our idea of market orientation to make it consistent with the most efficient combination of the factors of production. Lowest cost access to the market will create the desired condition of supply to the market at the lowest delivered cost when distribution costs are a significant part of, or a significant variable in, the final delivered cost.

In the cement industry distribution costs certainly are high and complex and include other costs, beside direct transport charges, in the form of packaging costs and in distributors'charges and margins. The perishable nature of the product has already been mentioned. The dealers who are the main distributors of cement do not usually carry large stocks of cement and so all substantial orders are filled by the cement plant which ships them direct to the consumer. As the mill does not carry large stocks in bags this means that on each order bags must be filled and trucks loaded. It is therefore desirable that the mill be situated so that this can be done without undue delay and a near market location best fills this requirement. Of course the quality of available communications and transport services must be considered in the determination of what distance can be allowed in a "near" market location. ("Near" thus has dimensions of cost and time as well as of distance.) The significantly lower quality of these services in the past probably means that this consideration is more important in understanding the location of older plants. The alternative system of supply from a "distant" mill involves the creation of a supply depot in the market area. The extra charges resulting from double handling may not be significant under modern transport conditions as the depot could be located at a point where transshipment from, say, rail to road transport would normally occur in any case. In this way little extra cost is actually involved.

Two further points must be made about the locational effects of the cement industry's most widely chosen method of distribution, distribution through wholesalers. As far as the cement producer is concerned the wholesalers replace the final consumers as the customers for cement. The location of wholesale establishments in a centre can therefore cause that centre to have an effective demand in excess of its actual consumption: this can cause the effective centre of demand to diverge from the actual centre of consumption in an areal market and can further increase the attraction of large urban centres where wholesale facilities may be established. The final point which indirectly concerns market orientation is the effect of the distribution system on prices, one of the major variables in the location decision. As discussed earlier the difference between price and outlays the gross profit, determines the transportability of the good. However the matter of price can be dealt with more fully along with other factors related to the demand for, and the market for, cement in the next chapter, after the following discussion on the nature of the competition which helps to determine prices.

Isard has made another contribution to the understanding of market orientation in his examination of the nature of the competition involved. He says, "for most situations of the space-economy, it is quite meaningless to apply the norms of pure competition" and "progress along Chamberlinian lines ... is a <u>sine qua non</u> for developing further the theory of the space-economy ..."[36.] Isard supports his contention by the findings of Weigmann, Chamberlin, Losch, Palander, Hoover and Smithies.

Isard states that in Weigmann's attempt to formulate the foundations for a realistic economic theory, "the first principle that Weigmann establishes is that a theory of space-economy embraces a theory of limited competition. Actually all factors and goods, regardless of setting, face immobilities of varying extent in all directions; and, in accordance with the nature of the obstacles to movement, whether they be economic, social, political or cultural, markets are restricted in scope. The competition which any good or factor can offer to other goods and factors at different locations is incomplete. The existence of physical space implies

---

[36] ibid, p.50

immobility, limited competition, and spatial inelasticity (or negative spatial elasticity). Thus the generally accepted principle of pure competition is not applicable to the analysis of spatial economic processes."[37]

Isard also states that "the demand curve for the firm's product, as Losch has neatly portrayed, has a negative slope". "Because of the spatial spread of consumers and producers characteristic of reality, the demand curve for the individual firm's product, save for exceptional instances, is not a horizontal line of infinite elasticity at the price determined by the intersection of the demand and supply curves for the industry, as it is under the traditional pure competition. Rather, the friction of distance imparts to each producer a limited monopolistic position with regard to consumers closer to him transportation-wise than to other producers."[38]

Palander arrives at similar conclusions by reasoning that "if the various places in a region under consideration are treated as different markets (corresponding in this way to the varying local prices resulting from transport costs between these places), then the necessary condition of a large number of buyers and sellers for each commodity and factor at each market, cannot be fulfilled. If the region itself is viewed as one market, one could interpret the different prices ruling for a given commodity at the

---

[37] ibid, pp.37-38
[38] ibid, pp.158-9

various places within the region (1) as signifying non-uniformity of product, or better yet, (2) as signifying a uniform product in a persistently imperfect market where individuals are in monopoly situations in accordance with the advantages of their respective positions. Neither case could be regarded as pure competition."[39]

The most important consequence of imperfect competition is found in the nature of prices and price determination. Palander has pointed out "if one now discards the premise of pure competition, he must necessarily forsake certain supplementary simple principles which have served as scaffolding for general equilibrium theory, namely, that the price of a commodity equals average cost (the latter including a normal profit) and that the price of a factor equals the value of its marginal product".[40]

Finally Isard states that "price discrimination, which tends to be most expedient within spatial markets where distance and other geographic obstacles enable the producer to deal separately with the various sectors of his market, offers to the individual firm opportunities for additional profits."[41]

This idea of limited competition in a spatial market and of local monopoly situations due to the separation of centres of demand is basic to an understanding of the topic under consideration and will be developed further throughout the study. Although the

---

[39] ibid, p.43
[40] ibid, p.43
[41] ibid, p.164

concept is of general application, it is of particular importance in the case of industries where a limited number of large plants supply the required goods. This is the case in the cement industry.

Earlier in this section it was stated that transportability depended on gross profits - the margin between the market price and costs of production. Since monopolist control of a market allows the earning of excess profits then the distance over which the product can be transported is increased, the ties of the plant to the market it serves are lessened and the need for efficiency in location is decreased.

In this section the widely used, and often confused, concept of market orientation has been discussed at some length and what are considered to be the three major deficiencies in the usual treatment of the concept have been pointed out. It has been shown that in addition to the generally considered points of the nature of the product and its constituent raw materials and the nature of the freight costs, it is also necessary to consider the nature of the areal form of the market and the nature of the competition existing within the industry. Also it is important to recognize the level at which market orientation operates in the location decision.

As will be shown later conditions of imperfect competition and gross profits of a high order do exist in the Queensland (in fact, in the Australian) cement industry. The market area served by the Queensland cement industry is a large one with marked concentrations of demand at clearly defined and well separated foci. Marketing considerations have operated to determine the general situation of the cement plants near these separate foci. Therefore in this study it will be necessary to recognize those forces and tendencies which can operate to modify or disguise such an apparently simple tendency as market orientation.

CHAPTER IV

THEORETICAL FRAMEWORK (2): MARKETING AND THE CEMENT INDUSTRY

1. CEMENT PRODUCTION AND MARKETING

In this chapter background will be provided for an understanding of the market which the cement industry serves and the interrelations between the manufacture of cement and its sale. In simple terms, the way in which cement is made and the way in which it is sold affects both the choice of markets in which the cement can be sold and the choice of locations for the plant to make the cement. In this chapter some of these basic interrelated variables in the location decision will be discussed.

The first and third propositions of the thesis of this study relate to economies of scale in the cement industry. The assumption of the existence of these economies was one of the basic assumptions of the thesis. Argument for the existence of these economies will be presented first and the implications of their existence examined. The spatial form of the markets to be served, the nature of the product and the importance of price structures for the product are next discussed to show how these factors influence production and location. The fourth section of the chapter discusses aspects of the distribution process relevant to the cement industry.

The final sections describe the features of dispersal and concentration in the Queensland market and the changes that have occurred in it over the period covered by the study.

2. SCALE ECONOMIES AND MARKET SIZE

The first proposition of the thesis that is argued here is that the establishment and development of the Queensland cement industry has been consequent on the growth of an adequate level of established local market demand. It will be shown in the next chapter how establishment of the first plant awaited the development in Queensland of a market that could absorb at least 30,000 tons of cement annually. Quotations from statements made by people interested in the possibility of cement production at that period stress that this was an important consideration. But it is important to realize that, until recently, a similar consideration was of the utmost significance in determining if and when increases in the production of cement would be made. For an understanding of the development of the Queensland cement industry during the last fifty years this fact is of the utmost importance.

In this section and the next some aspects of two inter-related facets of the industry will be examined in some detail. The first is related to the size of the units of plant required to produce cement economically and involves such questions as the economies of large scale production (if they exist in this industry!), the means of increasing production to cope with increasing demand and the features of the market required to support such an industry. Particularly important is the fact that the market should be able to allow production to capacity if economies of scale are to accrue. However this poses the question of explaining the existence of excess capacity which is a feature of the cement industry not only in Australia but in the U.S.A. and the U.K. also, and which seems to be almost universal. The second facet of the industry to be examined is the nature of the market for cement. Some aspects of this market are related to the economies of production but others are related to the costs of distribution, the spatial separation of centres of demand, the uniformity of the product and the methods of determination of prices. This last aspect is important in explaining the existence of excess capacity mentioned above.

First it is generally recognized by economists that economies of scale are possible in capital intensive industries and the cement industry is usually considered in this class. Cement plants are usually large scale units and evidence on the economies of large scale production is found in writings on the cement industries of both the United States and the United Kingdom.[1] Evidence of economies accruing <u>solely</u> from large scale production

---

[1] Discussion of the nature of these economies is found in: <u>The Structure of British Industry Vol.1</u>, ed. D. Burn, Cambridge, 1957, pp 321 ff; W.Hildebrand, "The Cement Industry" in <u>Development of American Industries</u>, ed. J.G.Glover and W.B.Cornell, Prentice Hall, New York, 1949.

in Australian cement plants is not easily recognized. Hogan[2] states that the efficiency of cement plants in Australia shows wide differences whatever way such measurements are approached and that the cost structure of cement firms shows striking variations. He reaches the conclusion that although "some evidence exists for the belief that small plants have higher costs per unit of output than larger firms", "conclusions about average and marginal costs and economies of scale must necessarily be qualified by such limiting features as the size of markets and the relationship between output and productive capacity"[3]

This statement is open to misinterpretation. The necessity of qualification by certain limiting features should not be read to imply doubt as to the existence of economies of scale in the case of an individual cement plant. Hogan makes the point that the effects of such economies are not simple and direct but must be considered in relation to these other factors. In his words, for the industry as a whole, "the discussion of 'economies of scale' cannot be considered in terms of cost alone if profitability is the measure of entrepreneurial success. It is necessary to account for the structure

---

[2] W.P.Hogan, "The Structure and Development of the Australian Cement Industry, 1949/50 to 1959/60 - a Preliminary View". This paper, read to Section G, ANZAAS Conference, Brisbane, 1961, is "part of a wider investigation of the developments in Australian manufacturing industry over the past decade". C.Forster has completed a similar survey for the years, 1920-1930. There are no other known economic studies of the Australian cement industry other than these two.

[3] ibid, p.30

of markets in an economy."[4] Hogan does not explore the question of location as it is not directly importand to his topic but merely accepts that small high-cost plants can be afforded "natural protection" by distance. This final quotation from his study is a direct confirmation of points contended in this study. "A market of less than 100,000 tons a year might support profitably a small cement plant if transport costs from the nearest producer made a significant difference to the final price of cement by comparison with markets neighbouring the existing producer. Limited regional markets may easily support a number of small plants where distance and transport systems involve high costs."[5]

The range of plant sizes in each state of Australia means that the State aggregates in published statistics are of little use in investigating economies of scale for individual plants. The structure of the industry and the nature of the competition between the cement companies make the companies themselves most unwilling to release figures. But these difficulties with establishing the existence of scale economies are not something that is restricted to the cement industry in this country. Michael Chisholm, in Geography and Economics, in his discussion of economies of scale accepts the cement industry as an industry in which these economies operate. However he also says "The recognition of scale economies and the measurement of

---

[4]ibid, p.19
[5]ibid, p.19.

their magnitude does, however, present grave problems of definition, comparability of circumstances and the adequacy of statistics".[6]

But although statistics from the industry are difficult to obtain and manipulate it is still possible to reach some degree of certainty on the matter by arguing from another base. The cement industry has features which are inseparably connected with economies of scale: high capitalization, low capital turnover, a low ratio of marginal costs to overhead costs in the average costs of the plant, differences in production costs in favour of new larger plants over old smaller plants and increments to plant capacity by the addition of very large units. Further elaboration on these points is found in Appendix 6.

If these economies are real then the first inference is that a suitably sized established market is needed to warrant the building of a cement works which will be able to produce cement economically. The second inference is that increments in production will be large and expensive. Consequently the attitude of the entrepreneurs to the future prospect of the market

---

[6] Michael Chisholm, Geography and Economics, G.Bell & Sons, London, 1966, p.70.
In his description, pp.52-3, of the establishment of a new large cement plant at Dunbar, he said "Demand was great enough to warrant a plant sufficiently big to obtain most of the economies of scale of production".

will be of major importance in any decision to increase plant capacity. A decision to increase production at a site is therefore virtually a vote of confidence in the existing location of the plant.

Two modifications of the foregoing discussion on capital requirements are necessary. First, although a cement plant is centred on the kiln other ancillary equipment is vitally necessary for production. Available figures[7] indicate that production expansion involving kiln equipment necessitates very large capital investment, but when production is limited by ancillary handling equipment, expansion of production for a much lower investment is possible. Second, economies due to large scale production may be fully realized only when the productive capacity of the plant is fully utilized. Apparently, when production is substantially below capacity, manufacturing costs per unit of product rise drastically because of the high capital consumption charges which continue regardless of the level of output of the plant.

If this is the case then there is a need to explain the widespread, almost universal,existence of excess capacity which is antithetical to gaining the economies of large scale production.[8] In discussions of the cement industry in the United States or the United Kingdom this point is acknowledged but is concealed to

---

[7] Developments in Australian Manufacturing Industry, Department of Trade, 1957/58 - 1963/64.

[8] See S.M.Loescher, Imperfect Collusion in the Cement Industry, Harvard, Cambridge, 1959

some extent by the need to have the capacity to meet peak demand. In the middle and high latitude lands, cement production is characterized by wide seasonal fluctuations related to the seasonal trends in the construction industry. "This wide range in demand poses a problem to the cement industry. To serve the market it is necessary to have sufficient capacity to meet the peak seasonal and cyclical demands. A cement mill must operate on a continuous 24-hour basis. The output is determined by the number of kilns in operation. For example, in a four-kiln mill only four levels of operation are possible: 25, 50, 75 and 100 per cent. Because equipment must be maintained at the highest level of operation there is a tendency to develop excess capacity."[9]

This explanation is inadequate in the Australian situation. In his historical survey of Australian industry in the twenties, Forster suggests four reasons for the growth of excess capacity in the industry.[10] The division of Australia into six State markets meant that "the natural tendency to excess capacity (sic) was encouraged in six separate places" and "was encouraged also by the fact that public expenditure and building construction behaved in a different fashion in the various states." Further he suggests that manufacturers were too optimistic in their estimates of future demand

---

[9] E.Willard Miller, A Geography of Manufacturing Prentice Hall, Englewood Cliffs, N.J., 1957, p.434.

[10] C.Forster Industrial Development in Australia, 1920-1930, Australian National University Press, Melbourne, 1964, Chapter III.

and that they expanded capacity beyond actual requirements. He then adds that "the price policy of the existing firms induced new firms to enter the industry", a point that is probably more important than any of the three reasons given above. His fourth reason was that "it was natural, too, that in each state existing firms should deliberately create excess capacity in order to discourage potential rivals from establishing a business there". As will be shown in Chapter VII of this study, this was an important consideration during the period of geographical diversification within the Queensland industry.

The excess capacity noted by Forster has been found to be a common occurrence in many Australian industries. Hunter[11] in his discussion of factors working to the disadvantage of Australian manufacture says "Another, connected, disadvantage is the prevalence of surplus capacity in manufacturing industry. A particular set of circumstances is responsible for this. The Australian market is small in size, but in terms of population and income earning it is a rapidly growing market. Also government policy has made it clear that most important manufactures will be protected where possible. In addition, there has been a stream of new processes and products becoming available overseas for transfer to the Australian scene. Consequently the large overseas firms which are interested in investing in this country have competed intensively in many industries to secure their foothold for the future. To

---

[11] A.Hunter, "Introduction", pp 15-16 of Economics of Australian Industry, ed. A.Hunter, Melbourne University Press, Melbourne, 1963.

some extent this competition has taken the form of getting their capacity established first." The cement industry is one of the few large-firm industries in Australia that is largely owned by Australians but the ethics of competition and the strategies employed seem to be the same.

An alternative explanation for the existence of excess capacity is related to the method of making increments in capacity and to the cement firms capital amortization policies. As has been pointed out increments in production are usually made by the addition of new large productive units. In fact, during periods of rapidly growing demand, or when a small plant is being expanded towards the large size which is now technologically feasible and desirable, the new productive units may be as large as the whole of the existing plant. Such a decision may turn a deficient capacity into a large surplus.[12] Even though a surplus is not created by the new plant it may be possible to maintain old plant as extra capacity, as standby or reserve plant for emergency, for the filling of special orders or for use during peaks of demand. Where the old plant has already been written off by accelerated depreciation payments - before it is actually obsolete or worn out - then capital consumption charges on such plant are negligible. The existence of excess capacity created in this way is not antithetical to gaining the economies of large scale production.

[12] This situation is not unusual in large scale capital intensive industries. See N.R.Wills "The Basic Iron and Steel Industry", Ch.7, pp.215-246 in Economics of Australian Industry.

Indeed productive capacity in the form of plant on which there are no capital consumption charges is a valuable adjunct to a cement works. Since in the cement industry fixed costs form a large part of total operating costs, the lowering or removal of capital consumption charges is a very important economy to be able to effect. If the company's capital amortization policies have completely written off the original investment in plant then the only costs that have to be recouped are day to day production costs which are much less than the normal total costs in this capital intensive industry.

The implications of production from such plant have important bearings on the location question as will be shown later in regard to the continued viability of one of the Queensland cement works. On the one hand the ability to write off investment in plant and equipment weakens the <u>need</u> to continue production at some site for the reasons that are usually considered as the immobility of fixed capital. The cement industry with its high gross profits can write off investment in this way, and producers are not then bound to continue production at some previously chosen site. On the other hand, when they have written off their original investment they change radically their production costs at that site.

In discussion of the location decision earlier it was assumed that, because the level of production costs was largely determined by technological aspects of production, then there would be no variation between locations in the level of production costs other than raw material costs. But obviously in choosing between the continuation of production at an old site with fully paid-up plant and the establishment of a new works then production costs are a variable in the decision; and the variation works strongly in favour of the continuation of production at the original site. Under these circumstances fixed capital immobilities are not only a negative influence hindering mobility but are a positive inducement for stability. Thus the skilful managerial application of profits earned in years of satisfactory operation can be used to prolong the life of the plant when operating conditions become less satisfactory.

In this way plants in poor locations are able to persist in production creating a degree of stability or immobility in the locational patterns of the industry beyond what could be considered as economically normal. This aspect of the inefficiency of an industry with a monopolistic or oligopolistic structure could have caused some of the difficulty of explaining locations in areas where the industry has been established for many years. This in turn has probably been responsible for some of the lack of agreement among the divergent statements on the locational character of the industry.

3. THE MARKET FOR CEMENT.

The second proposition of the thesis relates to market serving. In the previous chapter the discussion of market orientation discussed the manner, method and level of action of the market's attraction of industry. It also placed the market in perspective as one of an array of factors of production and discussed the nature of competition in a spatial market. In the following sections attention will be directed to specific features of the cement market in Queensland. The first of these features is the degree of dispersal or concentration of the market, the second is the distribution of the cement to this market.

The first facet of dispersal and concentration that must be examined is the areal distribution of demand. In traditional economic analysis a market is treated as existing at a single point. In a small compact national area where highly developed forms of transport minimize transport costs and "spatial friction" a national market may reasonably be regarded as a single market for certain easily transported commodities. However for a bulky, perishable commodity in a country as large as Australia it is not wholly reasonable to speak of one market. The Federal political structure reinforces the effect of distance in making the Australian market a set of markets interdependent only to a marginal extent.[13] The individual State Governments over the past decades have vied

[13] However interstate road shipments of cement enjoy some advantage because of constitutional provisions regarding interstate trade (but also because of the lower charges associated with transport contracts for bulk shipments).
See also A.J.Robinson, "Regionalism & Urbanization in Australia", Economic Geography, Vol.39, 1963, pp 149-155

one with another in attracting new industry and fostering the growth of existing ones. Any treatment of the development of an industry in Australia cannot ignore this fragmentation of the market due to political structure and the basic spatial separation of the concentrations of population.

Another aspect of marketing conditions that should be stressed is related to the nature of the product itself. Cement has to be produced to certain standardized specifications on which there are rigid governmental controls so as a result there can be little product differentiation in competition for markets. Only four varieties of portland cement are produced in Australia - Ordinary, Low Heat, High Early Strength and Sulphate Resisting. Within any one of these types the consumer should have no preference for any particular brand of cement except on the basis of price. Therefore market boundaries, assuming rationalization of consumer behaviour, can be fairly simply determined. The delivered cement price at any point will basically be the factory price plus handling charges and transport costs. Without this simplifying assumption the position is more complicated. First, the factory price can be varied for different classes of consumers or for consumers in different areas. Both of these variations occur in the Queensland cement industry. Second, the assumption of rationalization of consumer behaviour ignores all the promotional tactics of the firm other than the basic tactic of price variation.

As will be recognized product differentiation is very important in the marketing of standardized products. Despite the existence of these other factors, price is the main determinant of market boundaries and is the basic and most important relationship between supply and demand.

The demand for cement is a derived demand since it is affected by the factors controlling the construction market. The short period total demand for cement moves noticeably in response to fluctuations in building activity. However since the demand for public, and many private, construction projects is fairly inelastic with respect to price changes in one building material, it seems that fluctuations in the price of cement have little effect on the total demand for it. This does not deny the fact that when the price for cement rises above certain levels it is often possible to substitute an alternative building material. But although the demand for cement is rather price inelastic it is geographically mobile and cyclically unstable. High temporary peaks of demand arise where and when construction projects are undertaken so that, when there are alternative possible sources of supply for a temporary demand in some locality, cement manufacturers could be exposed to considerable buying pressure by the contractors who are the final users of cement in large public and private projects. Cement producers use the distribution technique of selling to dealers almost exclusively as a device to lessen the impact of the constructors' bargaining pressures.

These bargaining pressures are of course greater where there are competitive suppliers and so are difficult to examine in this country. In Australia as a whole there is little real competition between the cement producers who either enjoy complete local monopolies in separated regional markets or sell their cement under conditions of collusion on prices. In the United States where there are a greater number of competitive suppliers Loescher has examined the situation in more detail in his study Imperfect Collusion in the Cement Industry. In this study he points out that producers consider that the product is "so highly standardized that a difference in price of a few cents a barrel will command the buyer's business. Yet the product is not so highly standardized that the customer is necessarily indifferent to brands when prices are identical."[14] As a result the producers strive to create some degree of product differentiation on the basis of a reputation for quality, of goodwill through service to customers, of the cultivation of buyers by salesmen, and the establishment of a reputation for reliability and for promptness of delivery.

The same promotional tactics are used in the Australian cement industry but, it would seem, in the hope of increasing demand rather than in an attempt to meet competition. The effect of these tactics, in seeking closer and more direct contact with the consumers, is to increase the desirability of a near market location.

At no time in the history of cement production in Queensland have conditions existed where the price of

---

[14] loc.cit., p.72.

cement could be determined by the intersection of a simple set of supply and demand curves relating to supply by the local producer and the local demand. An investigation of the plants in the Queensland cement industry at the time of their establishment is at the first of the Weberian levels of enquiry at which locational analysis is possible: i.e. at the level of "the small individual producer who has a negligible influence upon prices (with the exception of the price of his own product), the locus of consumption the supply costs and sources of factors, transport rates, agglomeration economies and other locational variables".[15] For such a producer entering into an established market where there is no other producer but an outside source of supply, the ruling market price is already set by the trade conducted to serve that market. The importance of this established trade is of great importance in the case of the Queensland market. As Isard has stated "(1) location cannot be explained without at the same time accounting for trade, and (2) trade cannot be explained without the simultaneous determination of location"[16]

---

[15] W.Isard "Location & Space Economy" Technology Press of the Massachusetts Institute of Technology; New York: John Wiley & Sons, 1956, p.92.

It is realized that long after the locational decision was made by the Queensland Cement and Lime Coy that some major cement users established plants close to the Darra works. This is, in some degree, an effect on the locus of consumption; but it is a small one and is not relevant at the time of making the original location decision.

[16] ibid, p 207

A premise of the first thesis proposition is that, if a region where a certain sized market exists is served from outside production sources, then the price of the commodity in that region is determined unless artificial barriers such as tariffs are imposed. This prevailing market price is of critical importance in determining whether or not production may begin in the region. A plant capable of serving that market can be established in the market area provided that the scale of production allows the commodity to be produced at a price at or below the prevailing market price. For the maximization of profits, the price is set at the level of, or insinificantly below, the import price. In Appendix 3 of this study are some relevant extracts from Tariff Investigations dealing with the cement industry. In the 1915 report can be found statements by company officials which state clearly that the price for the local product was determined in this way. This fact sheds extra light on the excess capacity problem considered above. The excess profits from such a pricing policy helped make possible the accelerated depreciation of plant which then meant that the level of capital consumption charges could not operate to enforce production to capacity. In other circumstances this pricing policy has allowed high cost, small scale plants to establish in small markets, shielded by distance from the competition of lower cost, larger scale plants.

In the case of the establishment of the Darra plant it will be seen that a significant increase in the price of cement, due to the disturbance of trade caused by the First World War, helped the struggling new company to establish itself firmly in the Queensland market. In the case of the later plants, an isolated regional market was to be served and the price of cement in that region was high because of transport costs. The high rail freight component in the retail price of cement offered adequate margins for a small local producer to compensate for the loss of margins due to large scale production. Therefore a small scale plant was an economic proposition. Thus in the Queensland case the economies of large scale production could not completely dictate the necessity of large scale plants. Rather, the distance between regional markets favours the establishment of smaller plants with a higher production cost structure, but a production level geared to the requirements of the regional market. It seems that the isolated fragmented Australian market shows several examples of this phenomena in other States than Queensland, suggesting that the concept of economies of scale in the Australian cement industry is of limited applicability in view of the size of the markets to be served and their geographic separation.

4. TRANSPORT AND MARKETS.

The aspect of the cement industry that receives most frequent reference in a wide range of industrial studies is the importance of distribution costs in determining the price of cement, and hence its competitive position in the market. At a more general level, studies in the fields of investment theory, production theory and location theory stress the importance of distribution costs in the original decision on the location of a plant.

The two topics named in the title of this section and the relationship between them should be treated as part of a more comprehensive subject, the distribution process. However any treatment of the distribution process introduces many problems. The process is only imperfectly understood and the existing body of economic theory has little in the way of practical help to offer. In Australia the situation is rather worse than in some other countries because there are virtually no government statistics for any part of the process, and there is a marked unwillingness on the part of those involved to release information. This unwillingness stems partly from the nature of industry in Australia and partly from Australian attitudes to distributors.

Hunter has pointed out that "one factor which vitally affects the competitive character of Australian manufacturing is the degree of concentration - the extent to which industries are oligopolized by a few firms or outright monopolized. It is generally conceded that Australia has an unusually high incidence of concentration".[17] The main effects of this concentration are seen in pricing policies and restrictive

[17] A. Hunter (ed.), The Economics of Australian Industry, Melbourne University Press, Sydney, 1963, p.6. The remarks quoted here are from the Introductory Chapter written by Hunter.

practices and, as Hunter also points out, "the main impact of restrictive agreements is so frequently upon the distributive sector of the economy".[18] However restrictive trade practices have so long a history in Australia that they are seldom referred to as such. Instead such euphemistic terms as "orderly marketing", "approved dealers" and "legitimate channels of trade" are common. The Australian cement industry shows these features: a high degree of concentration and the practice of orderly marketing through approved dealers. The implications of this imperfect competition on the location decision is dealt with elsewhere in this study.

Distribution costs involve more than just transfer costs which are greater than simple transport costs, and in a country such as Australia where goods are distributed over large distances the transport costs alone are very large. Prevailing Australian attitudes to the distributor attribute to him the whole of the difference between the basic cost of the article and the final retail price.[19] Although this is an unreasonable attitude it does affect the unwillingness of distributors to release information.

Even without this reticence it is difficult to evaluate or measure the efficiency of the distribution process. Firstly the process is really a chain of intangible processes, and, while form utilities created by the effort and process of physical production are

---

18 ibid, p.7

19 See S.J.Lengyel & R.M.Beecroft, The Cost of Distribution of consumption goods in Australia and elsewhere, Faculty of Economics & Commerce, University of Melbourne, 1949.

clearly apparent, place and time utilities achieved by distribution are not. Secondly production and distribution are really one continuous process and to separate them is to make an artificial distinction or, at best, an arbitrary division. A large part of the total costs of distribution is incurred in the production or manufacture of any good and this point has several aspects that are of significance in this discussion also.

Basically the decision on where to locate determines simultaneously the input costs of the factors of production on the one hand and on the other the costs of taking the finished good to the market: that is, it determines simultaneously the levels of production costs and of the transport costs that are basic in distribution costs. Other parts of total distribution costs are decided by the methods of distribution which are chosen. "In his efforts to find for his products the shortest and most efficient ways to the consumer ... the manufacturer may decide to distribute them through a representative or a wholesaler ... or to do his own marketing directly to retailers and/or consumers ... Surely, the manufacturer will choose the method of distribution which seems to him most likely to create and maintain the demand for his products enabling continuous production to capacity, and possibly leading to expansion with a view to lowering the unit cost of his products sometimes even at the risk or certainty of thereby increasing the unit cost of distribution".[20]

---

[20] ibid, p.39

Half of Queensland's cement is sold by the producing companies directly to a limited number of consumers. The other half is sold to distributors who then can sell direct to consumers or to retailers. The cement, whether bagged or in bulk, leaves the works by road or rail; if by road, the customer's own or hired trucks are used with the customer being directly responsible for the transfer charges; if by rail, the railway wagons are brought in the spur line to be loaded in the plant and the "ex-works price" which includes the distributor's margin is an f.o.b. price and so the customer again meets directly the transport charges incurred in supplying the cement.

The arbitrary nature of the division between production and distribution is made apparent in a consideration of packaging. Packaging is unquestionably an element in distribution but under normal accounting procedures its costs are generally regarded as part of the total production costs. In the Annual Report of the Queensland Cement and Lime Company it was stated that the cost of bags was 10% of Darra manufacturing costs. When different types of packaging are required for different parts of the market an artificial differentiation is introduced into a uniform product.

It has not been possible to discover the level of costs involved in transporting materials used in the manufacture of cement but the costs of transporting the finished products are much easier to determine. The attitude of the Queensland cement firms to the question of transport is apparently typical of prevailing attitudes in the State. After a recent survey of industry in Queensland it was stated that "an attempt to discover the role of transport in the economy of the individual firm did not prove very successful, because the firm's attitudes to transport problems were curiously ambivalent. On the one hand, in relation to market expansion they often appeared to be overwhelmed by transport considerations, but as an actual production cost transport caused them little concern even when it appeared to be a considerable proportion of total cost. Most manufacturers felt that the competition from road hauling had lowered transport costs and improved services in a very real sense during the 1950's, but there their interest ended. Competitors in the same location had to meet the same transport costs and, because most products were sold "ex works", individual firms were unconcerned with transport as a cost. Such reasoning seems to relegate transport costs to an undeservedly low place in the firm's economic considerations throughout Australia, and leaves any exertions for improved services and lower costs to the transport industries themselves".[21] This general statement describes the situation in the cement industry also but, as there are no "competitors in the same location", there is even less concern with transport costs.

A distinction is often made by transport geographers between "minimum cost transport" and "premium service transport", and it is useful to recognise that industries which require the latter may ignore locations

---

[21] M.Gough, H.Hughes, B.S.McFarlane & G.R.Palmer, Queensland: Industrial Enigma, Melbourne University Press, Melbourne, 1964.

on minimum cost transport routes even though these locations seem to offer lower assembly and distribution costs. Water transport is of use only in bringing coral from Mud Island to Darra. Apart from this the situation at each works is that rail transport offers the minimum cost transport and the cheapest way to serve the more distant parts of the market. On the other hand road transport is the only form of premium service transport but it also offers the cheapest way to serve the small, dispersed centres of demand in the nearby urban market. There is a very real limit on the distance from the works for which road transport is cheaper than rail transport. This is a result of the State Government's flat rate tax that must be paid by road hauliers when in competition with the railway. However, as a result of the fact that no State taxes can be levied on interstate shipments, road transport is used to serve the Northern New South Wales market. The main result of the difference in freight charges is to divide the market area so that road transport is used by almost all customers within sixty to eighty miles of the cement plants. Outside this distance almost all cement is carried by rail.
In the absence of government statistics and because of the large number of firms involved it is impossible to study directly the movement of cement by road. However a study has been made of the transport of cement by rail and this study has incidentally thrown some light on the road transport problem. A map summary of this study forms Appendix 4 and the facts established by the study are the basis for the maps in Section 2 of Chapter VIII.

However, this is not the place to consider these problems or these findings in detail. This section has been concerned with providing a general framework for an understanding of later parts of this study. As is pointed out elsewhere transfer charges are probably the ultimate locating factor in the choice of alternative positions in a spatial economy. The existing availability of transport and level of transport costs are dealt with in specific points throughout this whole study. This section has attempted to show at a general level the relation of transport to distribution and the location decision.

5. MAIN FEATURES OF THE QUEENSLAND MARKET

In the case being examined here the Queensland market must be recognised as a market area relatively separated from the rest of Australia. This market area is not undifferentiated as this would imply that there is one price ruling throughout and that transport costs within the market area can be assumed to be zero. Such is far from being the case. The Queensland market is itself a set of regional markets that have been served from one supply point as a single market only under unusual conditions.[22]

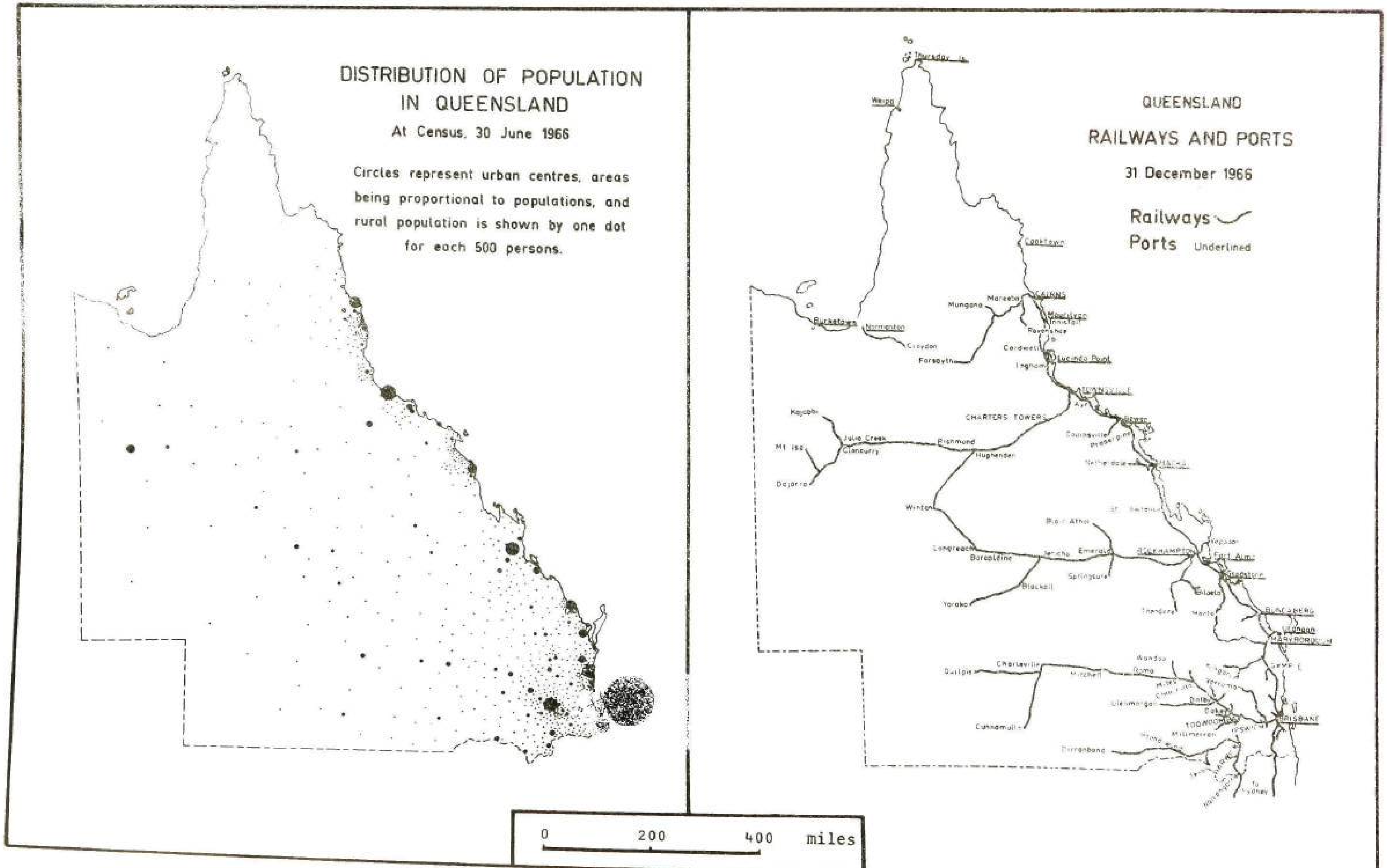
The core of the problem of regional markets is basically one of accessibility. Hence in Queensland the main bulk transport lines, the State Railways, have to a large degree predetermined the regional markets. The pattern is in contrast to that in New

---

[22] For example, during the Depression of the early Thirties and during World War II and the immediate post War years.

Fig. 5

FACTORS AFFECTING THE REGIONAL DISTRIBUTION OF MARKETS.



Source: Queensland Year Book, No. 28, 1967, pp.62 & 276.

South Wales where the rail system converges on Sydney and the main cement producers are centred around Sydney. In Queensland the main railway is the coastal one with secondary lines to the interior from Brisbane, Rockhampton and Townsville, and with much smaller lines inland from some smaller towns.

This pattern of rail routes reflects the distribution of economic activity in Queensland during the period of construction and has, in turn, affected later development. Maps of the large towns of Queensland, of the distribution of population over the State, of the areas of freehold land or of the most closely settled areas of agricultural production all reflect the pattern visible on the railway map. The size and importance of the cities at the junctions of the interior and coastal lines is, in part at least, related to the length of the interior rail line and the area of land it serves. As will be shown later in this study the pattern of demand for cement is such that the state may be regarded as three more or less independent markets. These markets occupy the areas served by the three great interior rail lines and each market has its major concentration of demand in the big city at the junction of the interior and coastal lines.

Given this threefold market pattern the main fact can readily be grasped about the situations chosen for the plants of the Queensland cement industry. The first plant was established close to Brisbane and was able to supply this first region and, under certain circumstances was able to serve the whole State from the capital. Subsequent growth of cement consumption led to plants being established in these other regional markets. This occurred when the markets reached a size capable of supporting a plant for which the production costs would be below the prevailing market price in the region. Note that the growth of cement consumption did not create the regional markets but merely made it feasible to establish plants in them.

Another special circumstance that must be considered is the set of tariffs and taxes that act as a barrier to oversea trade and as an aid to interstate trade. The importance of the existence and the high level of these tariffs during the period from 1910 to 1930 has been mentioned earlier and is elaborated in Appendix 3. Although the levels of these tariffs have been challenged, the tariffs have remained as a useful barrier against outside competition. Tariff protection has in recent years been of importance in shielding the newly-established North Australian Cement Company at a time when it would have been particularly vulnerable to the dumping of foreign cement.[23] The interpretation given to Section 92 of the Commonwealth Constitution has helped the Queensland Cement and Lime Coy. to capture a large market in northern New South Wales, but of course there are other economic and geographic reasons why the Darra plant should be able to supply areas of New England and the Northern Rivers.

An element of the concentration of the market that requires special attention is the proportion of the total production of cement utilized by a limited number of

---

[23]This point is discussed in more detail in Chapter VII.

large consumers. The "Asbestos Cement Goods" and "Other Cement Goods" industries now annually absorb over half of the total production and State Government works and contracts also absorb a large amount. The two industry groups in 1965-66 absorbed 58.7% of the total production.[24] The proportion used by the major governmental agencies is rather more difficult to assess. This is due to variations from year to year in actual purchases as one project is completed and another begun, and also to the fact that many governmental works are let to private contractors.

An important and interesting feature of the cement industry, in view of this dependence on a limited number of large scale outlets for production, is the lack of vertical integration in the industry. It could be suggested that this is related to the lack of competition in the Queensland market due to the monopolistic control of the market by the Queensland Cement and Lime Coy. for many years. However it is noted that a similar lack of vertical integration has been characteristic of the Australian cement industry as a whole even in States where there are several competing

---

[24] Manufacturing Industries 1965-66, No.1, Cement and Cement Goods, Bureau of Census and Statistics, Canberra. Company figures record direct government purchasing in the same year as 4.8% of the sales of the Darra plant, but this does not include local authority purchases.

producers.[25] It should also be mentioned that both the Queensland Cement and Lime Coy. and North Australian Cement Coy. have for short periods ventured into cement brick-making but in both cases the venture ceased upon the entry into the field of another brick-making firm. In reference to each case an official of the company concerned stated that "it was not the company's policy to compete with customers".[26]

6. DEVELOPMENT OF THE QUEENSLAND MARKET.

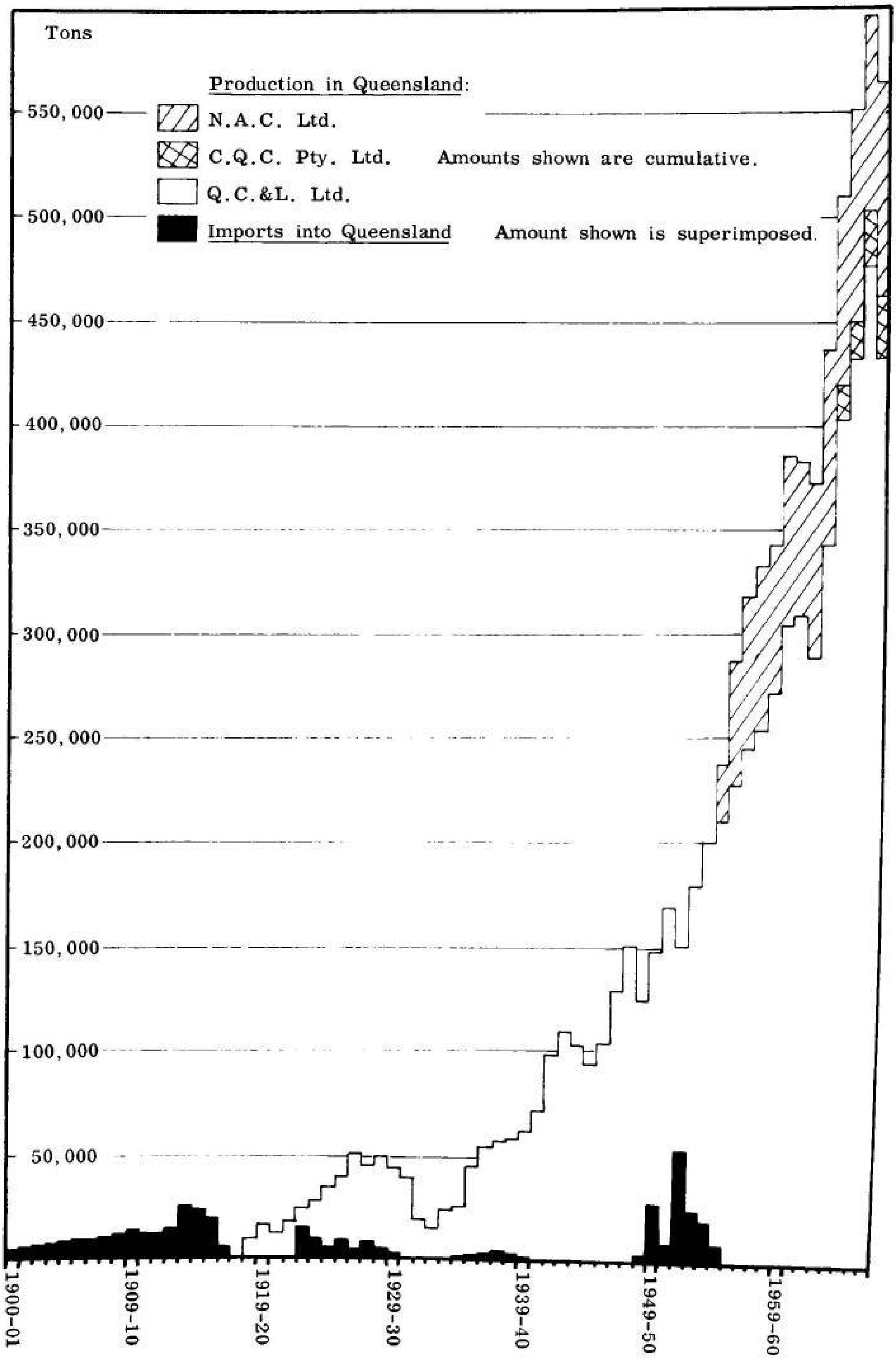
In the past fifty years the annual consumption of cement in Queensland has increased approximately twenty fold from about 25,000 tons to almost 500,000 tons. (See Graph 1). This rise in consumption has not been a steady one. In the absence of firmly established local supplies consumption was forcibly lowered during the disruption of overseas trade caused by World War I. After a rapid regrowth, consumption again declined during the depression years of the early 1930's. Annual consumption continued to rise until the early War years. Then followed a period of cement shortages and unsatisfied demand but since 1949 there has been a steady rise each year except for a minor drop resulting from the 1961 credit restrictions. This drop would have been more serious if it had not been for the additional purchases for the construction of the Mt. Isa railway line financed from Government revenue.

---

25. The one instance known of vertical integration was the take-over in 1960 of Standard Portland Cement Ltd. by Concrete Industries Ltd. (Investment Service, Research & Statistical Bureau of the Sydney Stock Exchange).

26. Private communications.

Fig. 6 Queensland Cement Supply, 1900 - 1967: Production and Imports from overseas.



Sources: Overseas Trade, from 1908 to 1967-68
Statistics of Queensland, Qld. Parliamentary Papers, to 1914.
Annual Reports of the companies concerned.
R.S.B. Investment Service

This great increase in the magnitude of the Queensland market has been accompanied by many changes but it is doubtful if there has been any significant change in the areal distribution of the market. It has not been possible to obtain figures for cement sales by regions in Queensland over the whole of the period under consideration but certain figures are available for selected years from 1945-46 to the present. (See Table 3).

TABLE 3.

Regional Distribution of Cement Sales

District	Percentage of Total Sales				
	1945-46[a]	1949-50[b]	1959-60[a]	1960-61[a]	1961-62[a]
1. South Queensland (South & West of Gympie)	75.66%	74.5%	73.78%	76.31%	71.54%
2. Central Queensland (Maryborough to Rockhampton and West)	6.61%	7.3%	6.73%	6.22%	6.66%
3. North Queensland (North & West of Mackay)	17.73%	18.2%	19.49%	17.47%	21.80%

Sources a. Reports of the Director of Secondary Industry, Queensland Dept. of Lab. & Indy. 1961 & 1962

b. History Production & Utilization of Cement in Queensland 1951.

Note: In 1945-46 & years 1959-62 there were no imports of cement. In 1949-50, 29,303 tons were imported. These are included in total sales.

The figures available suggest that the distribution of the cement market in Queensland is closely related to the distribution of population. (See Table 4.)

TABLE 4.

District	Regional Distribution of Population in Queensland				
	Percentage of Total Population at Census, 30th June				
	1921	1933	1947	1954	1961
South Q'land[a]	66.4%	66.0%	67.5%	68.3%	68.8%
Central Q'land[a]	14.9%	15.1%	14.5%	13.8%	13.2%
North Q'land[a]	18.7%	18.9%	18.0%	17.9%	18.0%

a. Districts are defined as in Table 3

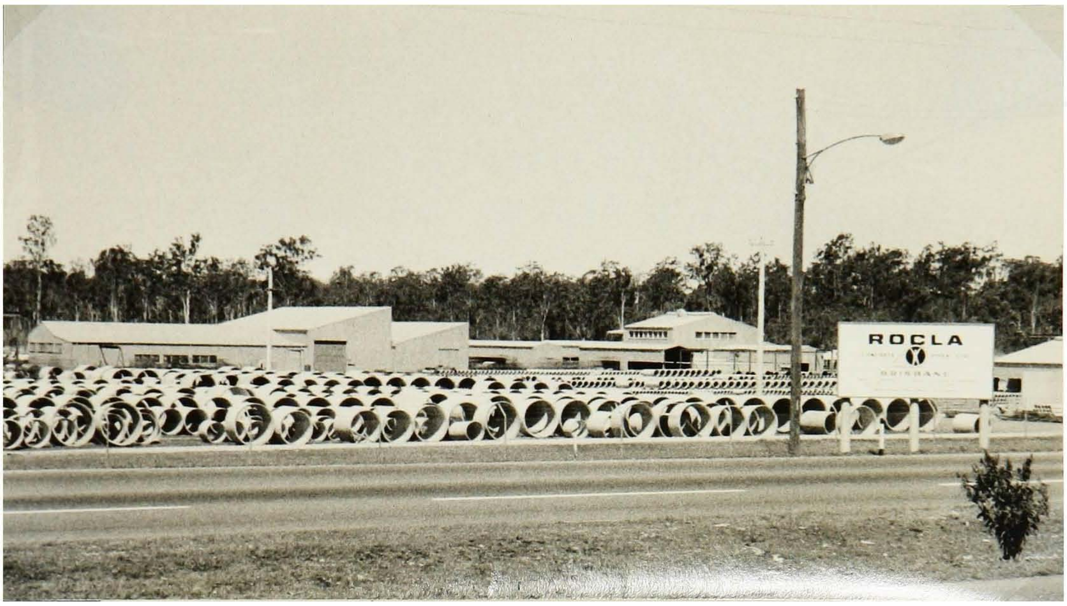
Source: Queensland Year Books 1948, 1955 and 1963.

The population of Queensland, as revealed in the Census figures from 1921 to 1961, has been distributed in a pattern that seems fairly stable. Approximately 68% are resident in Southern Queensland, 14% in Central Queensland and 18% in Northern Queensland. Comparison with the figures shown in the previous table reveals a high degree of correlation. Discrepancies such as the abnormally high percentage of sales in Northern Queensland in 1961-62 probably reflect the existence of Government construction projects in this area during the credit restrictions discussed earlier. Because of the high degree of correlation of the cement sales distribution figures and the population distribution figures for the period since 1945, the distribution of the Queensland market may be regarded as having been fairly stable over the whole period since 1920. In this time there has been a great increase in population, industrial development and major public works in South-eastern Queensland; this reinforcement of its position as the main focus of the market has ensured the viability of the Darra works and has given the Queensland Cement and Lime Company no inducement to make a major locational shift.

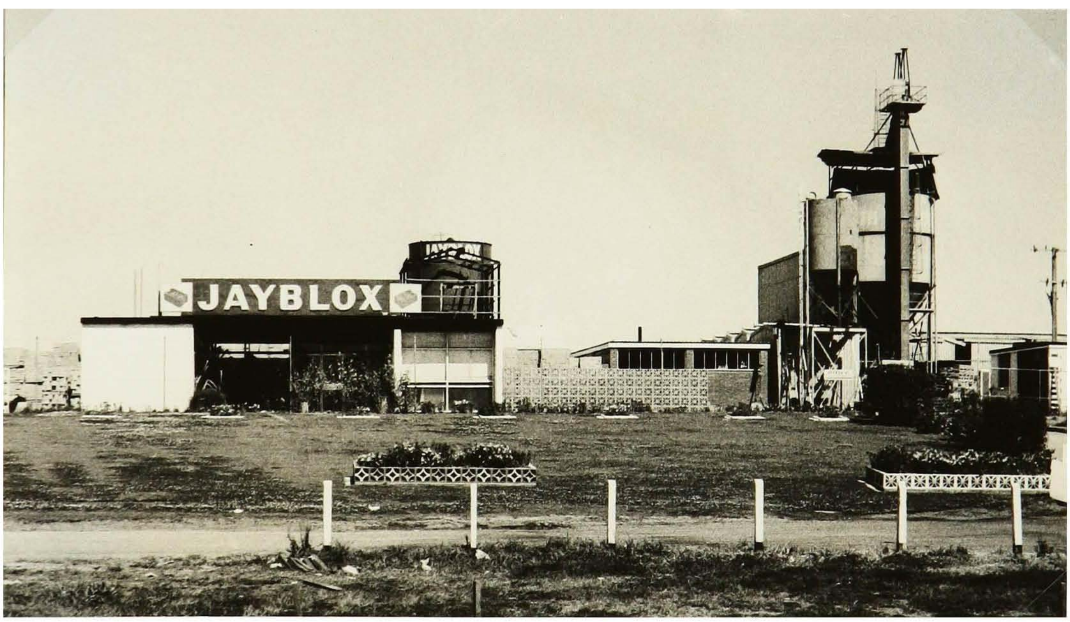
The greatest changes in the market have been the developments in the cement using industries. The most significant of these are the growth of the asbestos cement and other cement products ventures, and, in recent years, the large growth of the ready mixed concrete firms. These developments are not so much a change in the final uses of cement but the intercession of a whole range of intermediary firms between the cement makers and the building and construction industries. The main significance of these intermediary firms is that they have become the greatest single outlet for the product of the cement firms and, since these intermediaries are, in the main, large scale units, they have considerable bargaining power in the matter of the price at which they buy cement.

The choice of location of these large users of cement illustrates both the interdependence of the economic system and the changing circumstances which must be considered in locational studies. These large users located either close to the cement works or in their main market centres throughout the state. Their location became a factor in the development of the

CEMENT USING INDUSTRIES



ROCLA CONCRETE PIPES LTD. GAILES.



JAYWOTH INDUSTRIES, DARRA

industry. Thus, although their present location was not a factor in the original location decisions of the plants it has become a factor in all future locational considerations of the plants. In providing a market outlet close to the cement works or by concentrating demand in the major market centres they reinforce factors in the original location decisions.

Although in Queensland each plant is the sole producer in its own market area and so has no need to reduce its price in order to compete for markets, a price distinction between consumers still applies. The pricing policy of the Queensland Cement and Lime Coy. distinguishes between two sets of consumers. Just under half of the production is sold to distributors and the rest to "preferred users". These are the large customers and large bulk buyers - the various cement goods industries and the Government.

Parallelling the development of the cement goods industry and not unrelated to it is the trend towards the marketing of cement in bulk. This of course is also a result of a totally independent set of circumstances: the technological advances in road transport and the development of steel, bulk cement railway waggons. These advances have made possible a large increase in the proportion of concrete made by "site-batching". This is desirable as it is only by careful control of the proportions of the constituents that high quality concrete can be made. But as well as the better quality control that comes from site-batching, bulk purchase of cement offers even more direct savings.

Savings on the cost of bags, of bagging and of handling the bagged cement amount to more than 10% of the cost of the cement.

The development of bulk transporting methods have allowed the more distant bulk markets to be reached a little more cheaply. However the effect of this on the cement plants' ties to the market are involved and slighter than might be thought. This is because the rail freight rate for bulk cement is the same as the rate for bagged cement. The main savings to the consumer come from the lower price resulting from lower packaging costs and the convenience in handling. Most of the cement products firms have established in the Metropolitan area, some of them close to the cement works, but some such as the readymixed concrete firms have been established in the larger cities of the State. The consumers close to the works have low unit freight costs and have little case for reduction on such short hauls. The ready mixed concrete firms in cities away from cement works represent only a small group with little bargaining power for freight reductions. The other distant bulk users, creating large but temporary demands, are contractors undertaking large development works in various parts of Queensland. Since for the majority of these the Queensland Government is the ultimate purchaser of the cement, the Queensland Government Railways offer no concession on freights. As a result the development of bulk handling has had little effect in weakening the ties of the cement plants to their centres of demand.

All of the changes mentioned in this section have had the effect of increasing the degree of concentration of demand in the Queensland cement market. In consequence any influence that the market may have had in the original location decisions has been strengthened by developments during the growth and expansion of the industry.

CHAPTER V.

THE ESTABLISHMENT OF THE INDUSTRY

1. PRIOR MARKET CONDITIONS

Until 1917 the Queensland market for cement was supplied entirely by shipments from overseas and inter-state sources. Cement consumption in Queensland had risen gradually to 13,500 tons in 1910. A little more than half of this was supplied by direct imports from overseas while the remainder was imported through other states, the greater part being shipped from New South Wales. In 1910, of the 6,200 tons from New South Wales only 120 tons was of Australian manufacture.

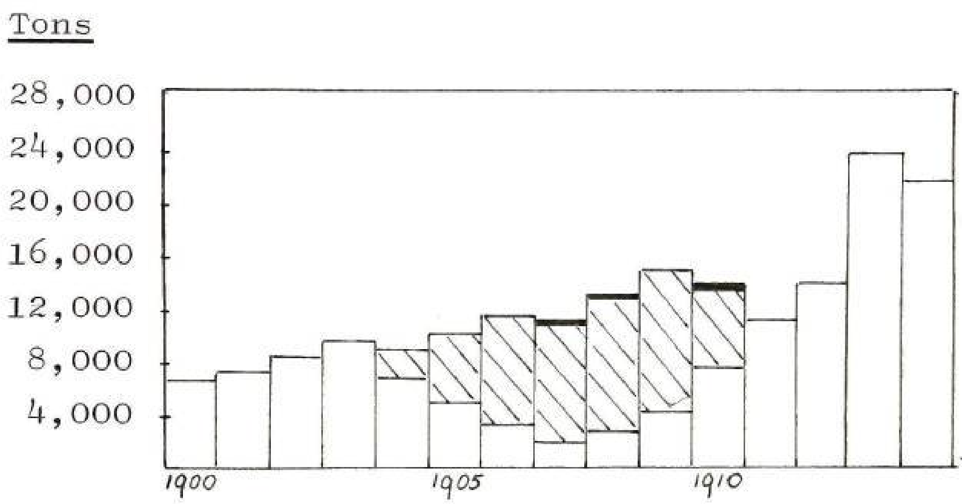


Fig. 7 Queensland Cement Imports 1900-1914

Direct imports, or total recorded imports

Re-Imports from other States) not recorded

Australian produce) after 1910

By 1914 the local demand was in excess of 30,000 tons per annum which made the establishment of a cement plant in Queensland a commercial possibility. Several companies were formed to investigate the possibility of the establishment of such a plant.[1] Because the Queensland Government was interested in the possibility of a plant being established, information on deposits of suitable cement making materials had been collected by the Government Geologist. This information was "available for the use of persons who desired to engage in the industry."[2] Although the party in power was willing to leave the establishment of such a plant to private enterprise, a member of the Labour opposition in the Legislative Assembly did suggest the "establishment of a State factory for the manufacture of cement"[3] but to little effect.

If the rise in cement use in Queensland was noteworthy, the increase in its use elsewhere in Australia was truly remarkable. A total of 325,000 tons of cement

---

[1]Statements recorded in Queensland Parliamentary Debates and in the "Daily Courier" of 1914 indicate the interest felt by many persons in the venture. Full details of the plans of companies other than Queensland Cement & Lime Coy. for the establishment of a cement works would offer valuable information on approaches to the location problem as seen in 1914. Unfortunately the only references discovered to another such company was that the Queensland Portland Cement Coy. Ltd. was registered on 29-1-1913 (Statistics of Queensland, 1913) and that this company was struck off the register by the Attorney General in May, 1914 (Queensland Government Gazette, Vol.CII, 1914).

[2]Statement by the then Minister for Mines, Mr. Appel. The Daily Courier Thursday, April 2nd, See Appendix 1.

[3]Mr. Barber, Member for Bundaberg, Queensland Parliamentary Debates 1914, p.1537.

were used in Australia in 1913 and at this time the per capita consumption in Queensland was only three quarters of the national average. Queensland, with 13% of Australia's population used only 10% of the cement; if the state consumption rate had been equal to the national average the state would have used not 35,000 tons but 45,000 tons of cement. The market situation would then have been even more attractive because, not only was demand at a sufficient level to support a plant, but there were very good prospects for future growth of demand. This demand was generated largely by government uses of cement in the construction of dams, in irrigation works and for water supply, for sewerage works and for harbour and railway works. Growth in demand in the private sector of the economy was not really important until the middle of the 1920's. Earlier building legislation had restricted the use of cement but, as the advantages and techniques of the use of concrete became more widely known, cement began making serious inroads into the markets for bricks and timber.[4]

The general public, encouraged no doubt by the success of cement works in other States, was only too willing to subscribe to an enterprise of this type.

---

[4] See C.Forster, Industrial Development in Australia 1920-1930, Australian National University Press, Melbourne, 1964. Chapter III of this book, "Structural changes in Building Materials: the Growth of the Cement Industry" is essentially the same as his article in Vol.34 of Economic Record, 1958, where he used the ironic subtitle "A study in competition".

In fact it was stated in a pamphlet circulated prior to the establishment of the Queensland Cement and Lime Company that "factories have been successfully established in New South Wales, Victoria and other States and in New Zealand, all of which are paying handsomely while the demand is greater than the supply".[5] Queensland investors would also have been aware of the results of a governmental inquiry a few months previously in New South Wales into the affairs of the Commonwealth Portland Cement Company. This company had a paid up capital of £100,000, and in 1913 had distributed a profit of £60,000, and over a nine year period had distributed profits of £400,000.[6] Such knowledge may have also "inspired the small number of public-spirited men in Brisbane to form a syndicate to finance and explore the possibilities of establishing a works in this state."[7] In a realistic survey of factors in the establishment of a plant by private enterprise, it is necessary to consider not only the fact of the existence of a demand but also the possibility of that demand being profitably exploited. It would appear in this

---

[5] ibid, p.1537. Mr. Barber quoted from a pamphlet by a Mr. Morry which was circulated in early 1914. In the Queensland Cement & Lime Coy. history published in 1951, the credit for the selection of the Darra site, on which the company established its works, is given to Mr. Morry. (See Section 4 of this Chapter.)

[6] ibid, p.1537. The use of the term "distributed" may be inappropriate. In the evidence to the Interstate Commission Tariff Investigation in 1915 it was stated that the Commonwealth Portland Cement Coy. was a limited company with only two shareholders.

[7] History Production & Utilization of Cement in Queensland, Queensland Cement and Lime Coy. Ltd., March 1951, p.1.

case that the demand existed and the interested parties were certain that it could be profitably exploited. This supports the first proposition of the thesis being argued here that the establishment of the industry was consequent on the establishment of an adequate volume of local market demand. Perhaps sufficiently astute entrepreneurs could have recognized the possibilities earlier and could have established a smaller plant earlier. Still this could only have been done successfully if the conditions described in the first proposition of the thesis had applied.

It will be noted that it is merely stated that the particular case supports the proposition of the thesis and, for reasons given elsewhere, no proof is claimed. However the consistency with the thesis proposition is pointed out. It is not possible today to determine exactly what could have been the operating costs of smaller plants that could have been considered when demand was less than it was in 1914. However some argument on their relative efficiency is given later. It is reasonable to assume that no plant would be considered for which the production costs were expected to be above the prevailing price in the region. It is certain that the entrepreneurs in 1914 believed that the existing demand could be profitably exploited and further that the production costs for the plant they were considering were expected to be below the prevailing price in the region. It is the relationship between demand, price and cost levels that the first thesis proposition seeks to explain.

2. THE FIRST PLANT.

In June 1914 the Queensland Cement and Lime Company Limited was established "to acquire from Mr. A.C.Elphinstone and others an option of purchase of certain mineral leases and freehold lands, and to carry on the business of manufacturers of, and dealers in, cement lime and other commodities."[8] Prior to the establishment of the Company Mr. Morry had made proposals either for the establishment of "a works capable of turning out 20,000 tons per annum" in which case "the capital required to accomplish this would be about £60,000" or for a more modest scheme involving an investment of £40,000 to erect a 10,000 ton plant.[9] The plan which was finally accepted was a far larger scale one which would produce cement at a lower price. This plan was based on expert advice rather than the early estimates of the enthusiastic Mr. Morry who was an engineer but who was not experienced in cement manufacture.

Before 1900 cement was produced in vertical kilns which could turn out some 200 barrels (about 35 tons) in a period of from 10 to 14 days, each kiln being capable of producing, around a thousand tons of

---

[8] Investment Service, Research & Statistical Bureau, Sydney Stock Exchange, Q2, October 1958.

[9] Queensland Parliamentary Debates, 1914, p.1537. The proposals were made in the pamphlet referred to in ref. 5 above.

cement in a year. However the cost structure of the industry was revolutionized by the introduction of the rotary kiln which was introduced in the 1890's and which by 1910 was capable of producing from 1200 to 1500 barrels per day. This is equal to from 75,000 tons to 100,000 tons in one year. In the United States Geological Survey publication, "Mineral Resources of the United States, 1906" it was stated that a "500,000 barrel per year plant costing $550,000 was necessary to achieve economies of scale".

The kiln planned for Darra had a capacity at the lower end of what was then regarded as an economic size range but the ancillary handling equipment limited the plant capacity to only half of the kiln capacity. This compromise allowed the use of a technically efficient but expensive kiln without the burden of the extra capital charges that would result from having installed extra plant which would not be utilized at the planned scale of operation. The works would also be well equipped to expand production to supply the expected increase in demand.

In the early months of 1914, Krupps of Stuttgart were operating in Australia and this company tendered to the Queensland Cement and Lime Company to erect a plant of 30,000 tons capacity for a cost of £150,000 half of which was to be in the form of shares in the company. Although this tender was accepted the outbreak of War prevented this scheme from eventuating. This necessitated "a complete change of programme and the calling of tenders throughout the world. Another contract resulted, at a much enhanced price, for plant drawn from various sources and after many vicissitudes including the sinking and seizure of many units and the internment of the Works Manager,"[10] the plant was built at Darra by 1916 and the company's manufacturing operations began in 1918.

3. THE LOCATION DECISION

In a location study such as this it is important to know the nature of the location decision being investigated. If the decision was an irrational one it is of little use to investigate how or why it was made, though it may be important to consider how the industry progressed when there was such apparent unconcern about its location. If the decision was a rational one then the methods by which it was reached are significant.

It can be demonstrated for the case under investigation here that all the relevant location factors were considered in reaching the decision, that those making the decision were competent to do so, and that their decision was ratified by one of the most competent authorities at that time. Evidence for the first-

[10] History production & utilization of CEMENT in Queensland, Queensland Cement & Lime Company Limited, 1951, p.1.

mentioned point comes from statements by officers of the company and from figures in the prospectus for the company. These include reference to all of the factors which are known today to be relevant. Evidence for the second point comes from both the ratification and the successful outcome of the decision that was made. The third point is made because the Krupps Company which was to supply the machinery was willing to accept payment in the form of shares in the new company, and had given a large cash guarantee that their plant would make cement economically at the chosen site at Darra. (See sections 2 & 4 of this chapter and Appendix 3)

There can be no doubt that the decision was a rational one but it was based on data that is no longer directly available. However it is possible to reconstruct the problem in part at least. The information that is available provides certain knowledge as to what facts are relevant for such a decision and allows assumptions about much of the data that was needed for the decision. It will be shown that consideration was given to the availability and costs of raw materials, fuel and power, transport, labour and management and the costs of capital amortization. Also considered were factors related to market size, distribution of demand and level of production.

In establishing a cement plant in Queensland the company had to make location decisions at both the broader regional level and at the level of choosing the exact site. The second proposition of the thesis being argued here is that the industry is at the broader level primarily market oriented. It will be shown that a location near Brisbane is not the most convenient place for assembling raw materials and fuel which were available in many other parts of the state, but that such a choice of location was primarily related to market considerations.

Although there exist no statistics of consumption of cement by regions in Queensland to verify the concentration of the major part of the market in any particular portion of the State, it is obvious that it was in south-east Queensland close to Brisbane. The concentration of population in this part of the State, particularly the concentration in the metropolitan area, and the importance of the use of cement in urban construction all indicate that this area was in 1914, as it is today, the major section of the Queensland market. This major focus of demand was served by imported cement arriving at the port of Brisbane so that Brisbane was also the effective, competitive supply point for the market. To the organizers of the new company the matter of freight costs was felt to be all important in the economy of their plant, and they were very conscious of the high level of transport costs in Queensland. (See Appendix 3). These factors meant that for the new company the critical figure for their product was the delivered price in Brisbane. All prices for the rail (and dray) hinterland of Brisbane were related to the Brisbane price. Prices for imported cement at other ports in Queensland were only slightly higher than the Brisbane price and the new company felt it had little chance of competing in these other areas. It was therefore essential to be able to compete in the main focus of the market, in Brisbane, especially since the plant was to produce some 30,000 tons when the total Queensland demand was only 36,000 tons. Adding to the desirability of a market location to minimize delivered costs would have been the prevailing ad valorem freight rates which favoured movement of raw materials rather than of manufactured goods.

Further reinforcing the attraction of the Brisbane area for the situation of the plant would be those agglomeration economies which can be gained from location near a major urban centre. Such a location allows the use of many facilities (transport, power, water) and specialized and auxilliary industrial and repair services available in large urban centres, and makes available a more economical, and often more assured, supply of many production inputs.

These considerations of course could set only broad regional bounds for the situation of the plant. To proceed to an understanding of the site chosen for the plant it is necessary to investigate more closely the production factors involved. These production factors may be conveniently treated under the broad groupings of raw materials, power and fuel, labour and transport. The known availability of each of these factors in 1914, and the costs associated with them at that time, will be used to reconstruct this aspect of the location decision.

Portland cement can be produced from a range of raw materials containing calcium, silica, aluminium and iron oxides provided that they can be proportioned in such a way that the desired chemical combination by heat is possible. The proportions of the materials used have not varied significantly in the past fifty years. The raw material from which calcium is obtained is some form of calcium carbonate such as limestone, the source of silica may be sand or the siliceous fraction of clay or shale, which substances are usually also the source of the aluminium and iron oxides.

In order to make one hundred tons of cement, approximately one hundred and thirty tons of calcium carbonate, about six tons of argillaceous material such as clay and some eight tons of arenaceous material such as sand are required. The products of chemical combination and fusion is known as clinker and in the final processing after grinding the clinker, about four tons of gypsum (calcium sulphate) are added. The other requirements are about thirty tons of coal, which in the kiln provides the required temperatures for the chemical processes, and about one hundred tons of water. This latter may be distinguished as an ancillary rather than a basic raw material as it does not enter into the final product. In the process of grinding and moving the production materials at the plant approximately 120 kilowatt-hours of electric power per ton of cement are consumed. These fuel and power requirements are quite flexible: fuel oil or natural gas can be used in the kiln and coal - or oil-burning engines could be used to move and process materials.

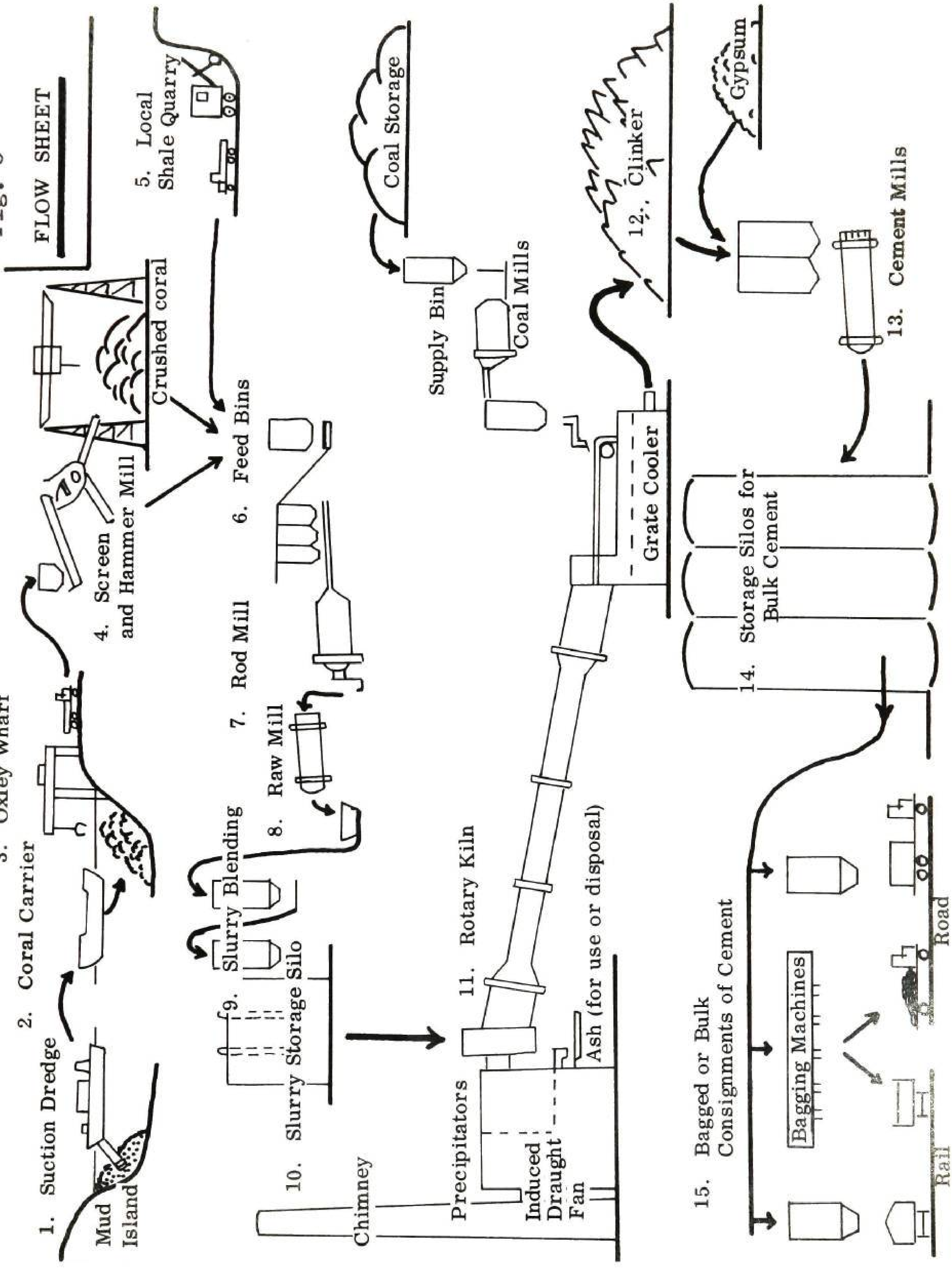


Fig. 8
FLOW SHEET
1. Suction Dredge
Mud Island
2. Coral Carrier
3. Oxley Wharf
4. Screen and Hammer Mill
Crushed coral
5. Local Shale Quarry
6. Feed Bins
7. Rod Mill
8. Raw Mill
9. Slurry Blending
10. Slurry Storage Silo
11. Rotary Kiln
Coal Storage
Supply Bin
Coal Mills
Grate Cooler
12. Clinker
Gypsum
13. Cement Mills
14. Storage Silos for Bulk Cement
15. Bagged or Bulk Consignments of Cement
Bagging Machines
Rail
Road
Chimney
Precipitators
Induced Draught Fan
Ash (for use or disposal)

To place one ton of cement on the market involves the assembly of three tons of raw materials for its production and then the distribution of that ton of cement. Obviously a cement plant has to have direct access to a route of easy transfer which is capable of handling a large volume of bulky, weighty, low-value goods. Rail transport in 1914 was the most satisfactory solution available to the problem and a site on a railway line was of prime importance. Equally as important to the location decision must have been the fact that only raw material deposits close to rail lines could be considered without involving extra capital outlay. The nature of the rail freight structure is of vital importance to this study. A brief investigation of the following figures taken from the Queensland Government Railways Rate Book for 1914 makes obvious the ad valorem nature of the freights and the high set rate for the minimum distance block. The first column in Table 6 gives the charges per ton for selected distances for the "M" class of goods which covers all minerals including limestone and coal. The second gives similar figures for "A" class goods under which classification cement was carried. In the third column the ratio between the "A" and "M" rates has been expressed as a percentage.

TABLE 6

Relationship between Rail Freight Rates in 1914.

Miles	(i) M s d	(ii) A s d	(iii) $\left(\frac{A}{M} \times 100\right)$ %
1-10	1-3	2-6	200%
15	1-8	3-2	190%
20	2-1	3-9	180%
25	2-6	4-5	177%
50	4-7	7-6	164%
75	6-8	10-8	160%
100	8-9	13-9	157%
125	10-4	15-10	153%
150	11-11	17-11	150%
175	13-6	20-0	148%
200	15-1	22-1	147%
225	16-1	23-7	146%
250	17-1	25-1	146%
600	30-1	44-1	146%

Since less than 130 tons of good limestone are needed to make 100 tons of cement it will be seen that it was cheaper to transport the amount of limestone needed to make the cement than to transport the cement.

Where the sources of inputs and the market lie along a single line of transfer it would be possible to locate a processing point anywhere along this line. However it has been demonstrated abundantly elsewhere -- and indeed it should be intuitively obvious -- that where the freight rate is graduated and so is less than proportional to distance, an end-point solution to the location problem is the optimum. This means it is less expensive to ship a good for the whole distance to be covered rather than to break the journey into two parts. Reference to the preceding table will show, for instance, that a single journey of 200 miles costs less than two of 100 miles or one of 50 plus one of 150 miles. Further reinforcement for an end-point solution comes from the fact that there is a large increment in shipping charges from zero to the first zone compared with the increment for any other equivalent distance in any other zone. In the case shown in the preceding table it costs as much to rail goods for 1 mile (or part thereof) as it costs to rail them for the first 10 miles, or for 28 miles beyond 200 miles. As a result if goods have to be railed at all then they can travel 10 miles for no extra charge. The second important result is that, in the increased charges incurred by a broken journey there is a minimum where the break coincides with the end of the terminal zone. In the example given above the next lowest charge would be for two journeys of 190 miles and 10 miles. This means that if the exact end point solution is not available then the next best solution occurs at a point just inside the terminal block.

Although all of the materials which must be assembled in order to produce cement are fairly widespread, the limestone is perhaps the most critical of these raw materials. There are two aspects to this: the limited occurrence of suitable deposits and the amount used in the process. In Weberian terms, the limestone has a locational pull almost five times that of coal which is the next heaviest material used.

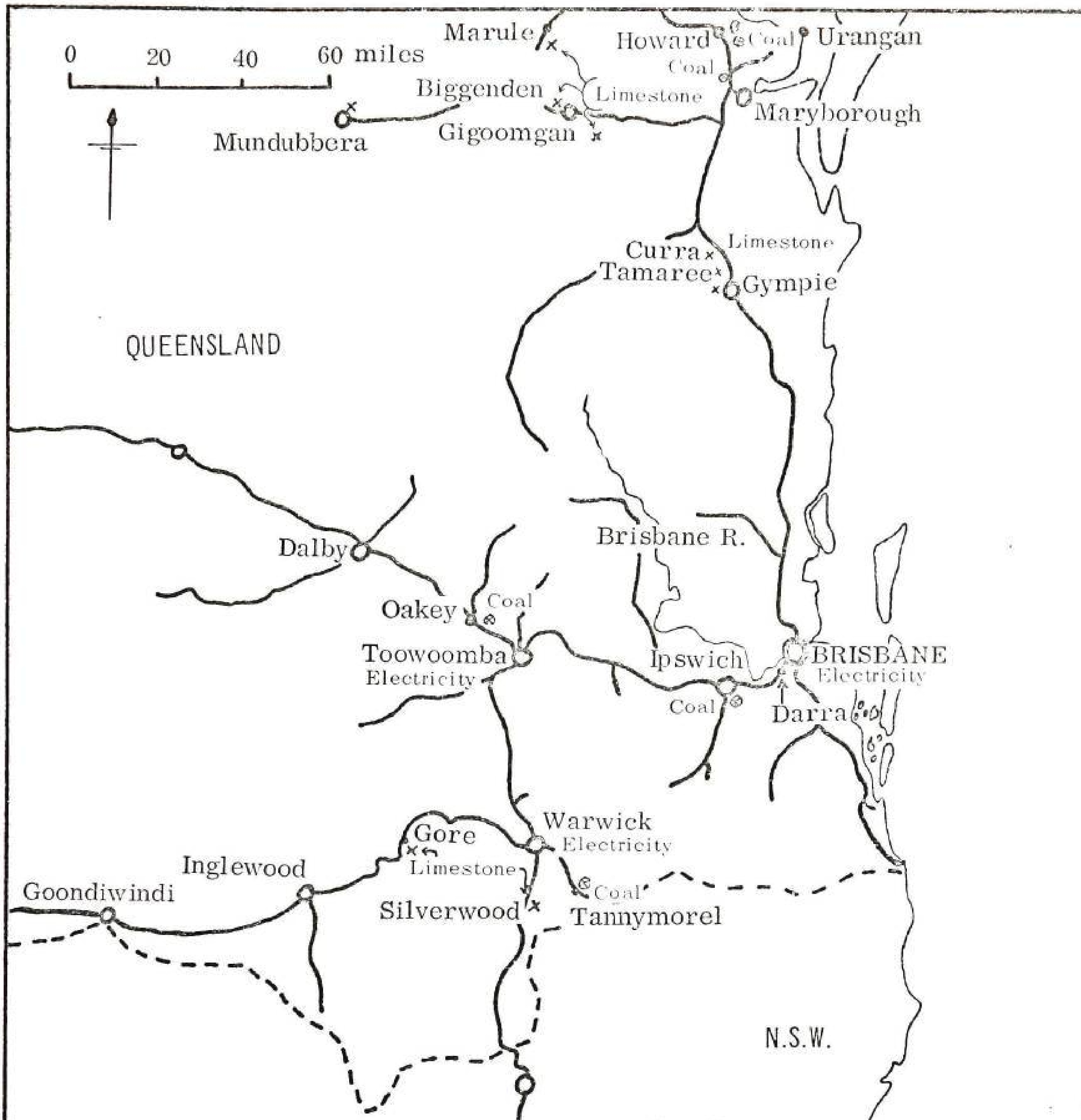
Further, in the production process there is a weight loss associated with the limestone of approximately 50 per cent.[11] These facts probably account for the ease with which the proposition has been accepted by some geographers and economists that cement plants are raw material oriented. No doubt cement plants have been built at the site of the raw materials but it is most likely that at the same time they had a situation which ensured easy access to the market. However in the case being studied here the plant was not built near the limestone source.

In 1914 limestone supplies were known in many areas of Queensland and some had even been examined specifically for their use in cement production (see Appendices 1 & 2). The main areas of interest were in
(a) north Queensland, inland of Townsville and of Cairns;
(b) central Queensland, near Rockhampton and south towards Gladstone;
(c) near Maryborough; and,
(d) south and west of Warwick.

---

[11] For further discussion of other aspects of the weight loss theory see Alfred Weber, Theory of the Location of Industries, Translated by C. J. Friedrich, University of Chicago Press, 1929; or more briefly in W.Isard, Location & Space Economy, Technology Press of the Massachusetts Institute of Technology, New York, 1956, p.225

Fig. 9



Location factors in 1914 - transport lines, sources of raw materials and power.

	Railway lines in 1914 (Queensland Yearbook, 1912).
Electricity	Towns with electric power.
Limestone	Deposits made known in report of Government Geologist, 1914.
Coal	Coalfields being worked in 1914.

The next most important of the materials to be assembled for the production of cement is the main fuel. In Queensland in 1914 this fuel was coal. Coal supplies were known in many parts of the State including some where there were limestone supplies. In North Queensland the coal mines and limestone quarries were more than 200 miles apart but in Central Queensland, in the Maryborough area and near Warwick these two main ingredients were found much closer together. There were also large coal deposits being worked in the Ipswich area: that is, close to the market but distant from limestone supplied.

The other important ingredients, the sands, clays or shales, are not restricted in location as much as are the supplies of limestone or coal. These more common materials may be regarded as ubiquities at the regional level when the general situation is being decided. However in the choice of the exact site, a location is usually chosen where these may be quarried as close as possible to the plant.

Another important site requirement is access to an adequate supply of fresh - but not necessarily potable - water. The water is needed simply for mixing with the crushed raw materials if the plant uses the "wet process" of cement manufacture.[12] In

---

[12] In the "wet process" the finely crushed raw materials are mixed with water to form a slurry which is then pumped into the kiln. In the "dry process" there are large heat economies as the water does not have to be driven off, but there is rather more difficulty in controlling the proportions of the ingredient raw materials and ensuring their thorough mixing.

texts from England, Europe and America the availability of water receives little mention, but in many areas of Queensland it will be appreciated that large supplies of water are not readily available. For the planned level of operation producing 30,000 tons of cement about 7 million gallons of water per year would be needed. Such a supply would be easy to provide anywhere in coastal Queensland but would be more difficult to provide in inland areas. However since a 7 million gallon supply would be very easy to provide in any of the areas with limestone or coal, any worries about water availability would have been related to the potential limitation of future expansion.

In 1914 electric power was available only in very restricted areas of Queensland. There were only eight "Electric Power and Light Manufactories" in the State. Two of these were in the metropolitan area and there was one in each of the following towns: Ayr, Charters Towers, Rockhampton, Thargomindah, Toowoomba and Warwick.[13]

On page 39 of this study reference was made to a rather inadequate statement on the location of cement plants. This statement said, in part, that the ideal location is one in which raw materials and fuel are in close proximity both to one another and to a large market. No such "ideal location" existed in Queensland. In the north Queensland case all three components were widely separated. In central Queensland

---

[13] Statistics of Queensland, 1914

the coal and limestone were closer to one another and close to a port but these ingredients were 400 miles away from markets of any significant size. In the Maryborough area coal and limestone could be found only 40 to 60 miles apart but it was then 170-190 miles to the main market centre. In the Warwick area there were limestone deposits but they were 200 miles from the market centre; the nearest coal was 50 miles away by rail but coal was available at various points along the railway to Brisbane. Finally, near the main focus of the market in Brisbane, there was coal available from the Ipswich area but the nearest limestones were some distance away.

It can be assumed that the actual processing costs of the new plant would not have varied widely from one possible site to another, except as the plant lost the agglomeration economies mentioned earlier. As a result, variations in the total production costs would be related mainly to the costs of assembling the main raw materials and fuel. These costs of assembly are basically a function of the distance separating the deposits and their assembly point. Similarly the costs of delivering the final product to the market are a function of the distance of the assembly point from the main focus of the market.

Thus, it is not necessary to show the costs of assembling raw materials and fuel, the costs of manufacturing and the costs of distribution of cement for a very large range of sites in Queensland so as to show Darra as the optimum site. All that is necessary is to compare the required transport inputs between locations in different regional situations. Only after the situation is selected is it necessary to define a site. The site thus selected can not be proved to be the optimum -- but the probability that any better site exists will be small, and the probability that a significantly better site exists will be very small indeed.

Applying this method of finding the optimum location in a reconstruction of the original problem, it is simple to eliminate the possibility of a situation in north or central Queensland. As the distances separating coal and limestone deposits in each of these regions exceeded the distances separating similar deposits in the Maryborough district, and further, as the distances to the market focus were greater, then the cost of the transport inputs would be greater.

The possibilities of manufacturing cement in the Maryborough district were examined in some detail by the Queensland Government Geologist and extracts from his reports are found in Appendix 1. All of his information was available to the directors of the new company but their solution of the location problem was quite different. In the Maryborough area the possible coal and limestone deposits were 40 to 60 miles apart and the nearest was then 170 miles from Brisbane by rail. Alternatively, an assembly point, as suggested by Mr. Dunstan, in the Aldershot - Colton - Takura area would be 10 miles from Urangan where a deepwater port was "being built", from which port there would be a distance of some 150 miles to Brisbane. There are now no figures available to estimate the cost of transport along this route to Brisbane but presumably it would be cheaper than the cost by rail. However this option was not taken and it can be suggested that there are two reasons for this. First, as the deepwater port was still "being built", there was no common carrier operating on the route and the new company would have had to provide extra capital for its own vessels for the route. Second, the cement delivered in this way would arrive on wharf in Brisbane with all the possibilities of water damage and its attendant need for packaging in casks instead of bags. The cement so arriving would have little to distinguish it from the imported cement. In the Maryborough area cement manufacture at Marule using Howard coal would involve the lowest cost in transport inputs and the earlier discussion makes it unnecessary to consider intermediate points along the route to Brisbane.

In the Warwick district the largest limestone deposit was at Gore but there were equally high grade but smaller deposits at Silverwood. Coal could be brought from Mt. Colliery (Tannymorel) some 20 miles to Warwick or else 70 miles to Gore which, as an end-point solution, would involve lower total costs for the transport inputs. Other coal supplies were available at Toowoomba (from Oakey) and at Ipswich, but once again the internal points involve higher costs than the end-point.

Lower total costs still would be involved if Gore limestone were to be taken to Brisbane and Ipswich coal were to be used. This is because Brisbane is the other end-point and advantage would be taken of the lower freight rate on limestone than on cement. When considering the possibility of manufacture in a near Brisbane situation it is necessary to consider the alternative sources of limestone at Mundubbera, Biggenden or Marule, at Silverwood or near Gympie. The first three of these are further from Brisbane and the other two areas had smaller deposits. In the case of these smaller deposits the directors must have felt either that they represented difficulties of extraction or that they had too limited a life to warrant their exploitation. The main advantages of the Gore deposit were its exceptional quality (as little as 120 tons were used per 100 tons of cement) and its huge size.[14]

The figures in Appendix 5 which show the calculations of transport inputs make it obvious that for every other situation the cost of assembling the raw materials and fuel was less than in Brisbane. The Brisbane situation on the other hand had its big advantage in the lower costs of delivery of the cement -- that is the situation near Brisbane was oriented not to raw materials but to the market.

[14] See section 4 of this chapter for a statement by the Company on the selection of the Gore limestone. See also Appendix 2 for a comparison of the main limestones available.

In defining the situation more precisely the fact that the limestone and coal are both available on the western line makes a situation close to this line more desirable than a situation in the Brisbane area on some other side of the metropolis. Further definition can come from the rail freight structure referred to earlier. The existence of a minimum distance block charge means that if location is not possible right in the centre of the city at the rail terminal, then location would be best at some point inside this terminal block distance. Also the closer location is to the outer limits of this block the lower will be the costs of getting Ipswich coal and the lower will be the land costs and local government charges -- economies that can be gained for no extra increase in freight charges.

The general situation could therefore be set as along the western railway line about ten miles from Brisbane.

The fifth proposition of the thesis being argued here is that the exact site of the cement plant is determined by the availability of a suitable area of land with the necessary clays and water supply and with access to both rail and road transport. Along the railway line from six to ten miles out of the city there are deposits of Tertiary sedimentaries known as the Corinda and Darra formations overlying Mesozoic sandstones and in places overlain with Quaternary alluvial deposits. The Tertiary shales and clays are mined for brick making and elsewhere for pottery. The site chosen for the plant was

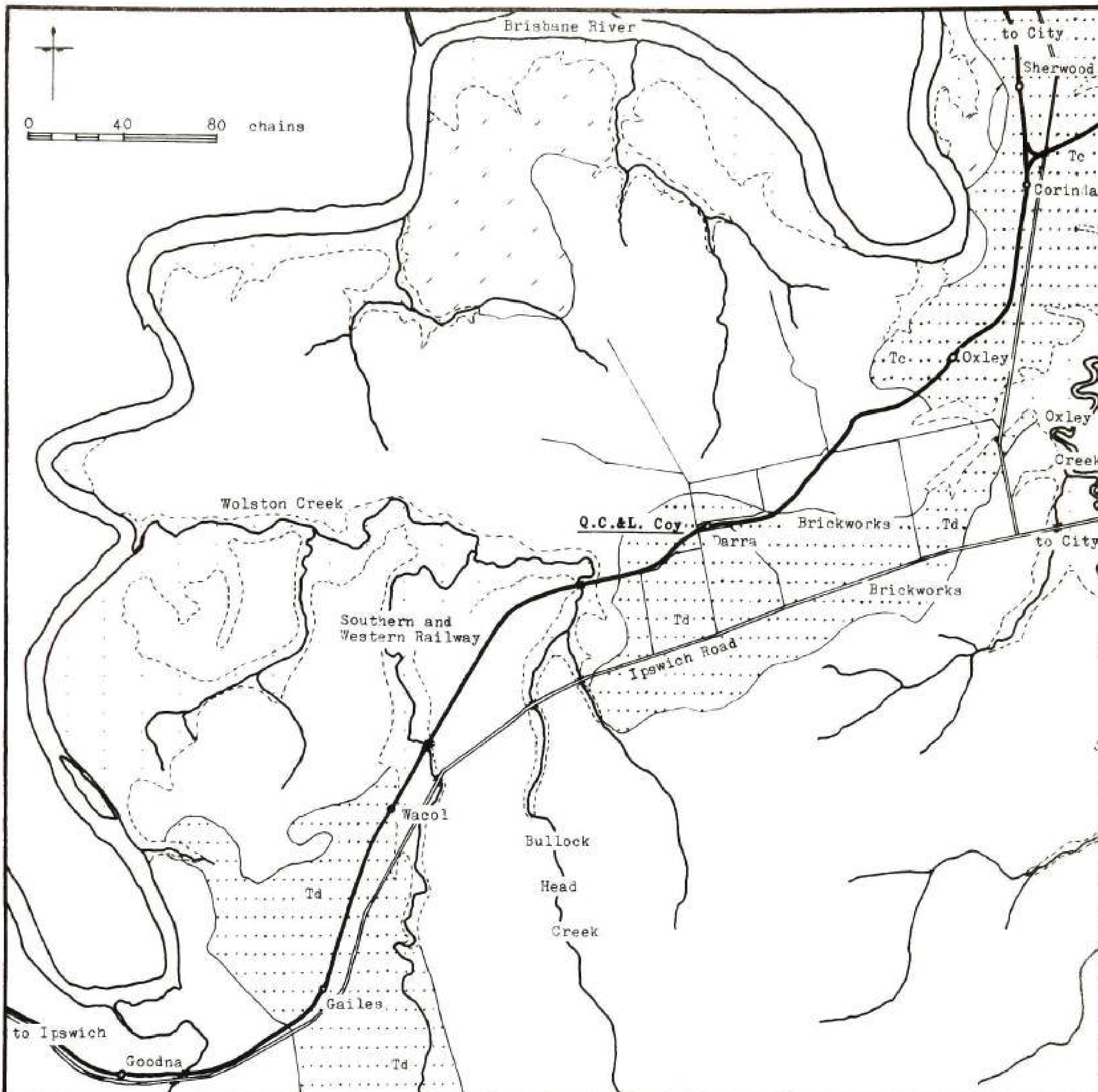


Fig. 10 **Site factors in 1914** - the sources of clays, sands and water and the main transport routes.

Geological formations

Quaternary		Alluvial sand, silt, mud, clay and gravel
Tertiary	Td	Darra formation - mudstone, siltstone and sandstone
	Tc	Corinda formation - mudstone and shale
Mesozoic		Sandstones and conglomerate with some shale
Paleozoic		Metamorphics

on the junction with the Mesozoic sandstones so that sands are also available.

Water is readily available throughout the area and the Brisbane River lies at no point more than two miles to the north and west of the railway. During the early years of the operation of the Darra plant the production of 20,000 tons of cement using Gore limestone and coal from Bundamba (near Ipswich) created more than five million ton-miles of traffic. When the site at Darra was chosen as having the necessary clays and water supply beside the railway line a spur line was built into the works from the main line.

Despite its almost perfect positioning at 9 miles 38 chains from Roma Street Station, there is no reason to suppose that the site chosen at Darra was the only one that would have been suitable along the five or six miles of railway from Oxley to Goodna. The availability of certain blocks of land was probably the deciding factor and when the articles of association of the company were drawn up it was stated that the company would buy certain blocks of land which were held under option by Mr. Arthur Morry and certain other pieces which he was under contract to buy.[15] These blocks form the basis of the company's holdings today although the company has since acquired other small sections for its private road.[16] The above mentioned articles also state that the mineral rights and leases at Gore were held by Mr. Morry.

---

[15]Company papers filed with the Registrar of Companies.
[16]From Titles Office records.

The final stage of the manufacturing of cement consists in grinding the clinker together with a retarder which prevents the too rapid stiffening of the cement paste. Gypsum is used as the retarder and, as none was mined in Queensland at that time, it had to be imported through the port of Brisbane. This minor factor would also have reinforced the attraction of Brisbane as a location.

The labour requirements of the works were not excessively large and labour costs do not represent a sufficiently large proportion of the final cost of the cement to make the labour factor of any great importance in the location decision. More important than the total amount of the labour costs is the fact that wage rates did not vary significantly from one part of the State to another. The plant in 1920 employed only one hundred men and a labour force of this size could be found quite easily close to Brisbane but it would be increasingly difficult and increasingly costly to obtain in smaller centres away from the metropolis.

The cost of packaging materials has always formed a significant part of the final price of cement. As a distribution cost under circumstances of real competition it would have played an important, if minor, part in the location decision. There were two reasons for this. First, the choice of location could determine the type of packaging and so affect the cost of production. Second, the choice of location could affect the cost of the type of packaging that was selected. In 1914 either barrels (6 to the ton) or jute bags (18 to the ton) were possible choices. The barrels cost 1/7 each or 9/6 per ton and were not reusable. The bags cost 4d. each or 6/- per ton and were reusable. This means that the cost of barrels was equal to one-quarter of the company's estimated costs of production or to just over 10% of the anticipated selling price. Since the final price for the cement was set by the competitive imported cement, the Queensland company would have to bear this part of the distribution costs as it would the cost of transporting the cement to Brisbane. A near-Brisbane situation from which the cement could be sold in bags would be the most attractive choice. Further the costs for the bags would probably be at a minimum in a near-Brisbane situation.

The discussion so far has been restricted to factors that are easily measured and can be ascribed some monetary value. Also of importance are some factors that are not so easily measured which are related to the marketing of cement. Some aspects of these have been discussed in the relevant sections of the previous chapters.

The problems in distribution and marketing arise from the perishable nature of the commodity and the need for the supplier to be in close contact with the consumers to ensure that the market can be supplied whenever the cement is needed. The setting up of supply depots in the market focus by a distant producing plant does not entirely solve the difficulties as the increased terminal charges involved in the double handling of the finished product can soon consume any cost advantage gained directly from transport and production costs. Further, such a "solution" does not resolve difficulties regarding perishability of product and customer contact. The standardized nature of the product is not so great that customers are indifferent to brands when prices are identical. As occurs in the marketing of most standardized products, the manufacturer seeks by advertising and the provision of special services to win customer allegiance. A special case of this would be relevant with regard to the Queensland Cement & Lime Coy. This company had its main competition in overseas imports and so was eager to capitalize on the "Queensland made" nature of its product. As the degree of parochial identification with a product depends on the closeness of association of the consumer with the place of production, then again the company had a reason to seek to be near Brisbane which was the main centre of consumption. Also there is the point that the directors were Brisbane business-men who would want both to be able to direct the company and continue their other business affairs.

Finally it can be stated that the location decision to build at Darra was a sound decision, justifiable on economic grounds. The prime concern was proximity to the main focus of the market which was also the competitive supply point. This proximity was made necessary by the nature of the freight structure and was encouraged by the nature of cement marketing and the availability of various external economies. The exact siting of the plant, though of some economic importance, was at the time a minor decision that could only marginally affect production costs within the general situation. As will be shown in later chapters this decision had far-reaching effects that could not be foreseen in 1914.

4. EVALUATION OF LOCATIONAL FACTORS - A COMPANY STATEMENT

The preceding discussion has attempted to consider the relationship of certain factors involved in the successful location of plants to the location decision made with respect to a particular plant. It has also been an attempt to reconstruct the conditions surrounding the establishment of the plant. It is not possible at this stage (some fifty years later) to describe how the decision was made. Instead it is only possible to consider the factors which are known to be relevant and to offer a rationale for the location which was chosen.

The Queensland Cement and Lime Company, almost forty years after its establishment, published a small history of cement production in Queensland. In this publication is the following statement on the decision to locate the works at Darra:

"The site for the works and the materials to be used were, in the main, those selected by the late Arthur Morry, an engineer in the Department of Agriculture and Stock, whose dream it had been to see Queensland making its own cement. The works site was Darra, chosen because it was on the railway, within the 10 mile radius of Brisbane, and contained many of the main cement ingredients, with the further advantage of being in close proximity to the Ipswich coalfields. There being no processible limestone in sufficient quantities nearer than Gore, this was adopted as the quarry site, but as it entailed a 200 mile rail haulage to the works, it was the one weak link in the plan of operations."[17]

5. SUMMARY AND CONCLUSIONS.

Thus it may be seen that in the first decade of this century the demand for cement in Queensland increased rapidly until it was large enough to support a works of a size which was considered economical at that time. The raw materials and fuel necessary were available although they were not located in such easy proximity as to make the establishment of a cement works an obvious possibility. Thus it was not until the demand was established that the possibility of profits inspired any entrepreneurial activity.

This activity resulted in the decision to build a plant and it is at this point that the location problem becomes relevant. The major portion of the market was in southeast Queensland, in particular in Brisbane, and was supplied largely through the port of Brisbane. The decision to locate the works close to Brisbane indicates a primary market orientation for the industry at the broad regional level. The location of the plant was

---

[17] History Production & Utilization of CEMENT in Queensland, Queensland Cement & Lime Co. Ltd., 1951, p.1.

then decided more exactly. The existing railway line and the location of the limestone and coal deposits must have made obvious the desirability of a location on this line to the west of the city. But having decided on the general situation on this line with access to limestone and coal, an exact site had to be chosen considering the need for suitable clays or shales and a certain water supply and the need for electric power and labour. The site chosen at Darra fulfilled all of these requirements.

In the following chapter the development of the industry will be traced to investigate changes in marketing conditions and in raw material and fuel supply, and the way in which these changes affected the original location decision and the long term viability of the plant

CHAPTER VI.

THE DEVELOPMENT OF THE INDUSTRY.

1. CHANGING MARKET CONDITIONS.

When an analysis is made of location factors for a plant that has been in existence for fifty years, it is not sufficient merely to investigate the factors involved in the initial location decision. The necessity of replacing major items of plant or the necessity of installing new plant to cater for a growing market would have meant that there were opportunities for relocation. In Chapter IV important aspects of the marketing of cement and topics related to this were discussed. In this chapter the growth of cement production at Darra will first be described and this will be followed by an analysis of factors in the continued viability of the plant.

From the previous chapter it may be seen that the Queensland cement market was a small, well dispersed but profitable one. It was profitable because it was large enough to support a cement plant but also because the price was set by outside supply and this price was high as a result of the action of both transport charges and tariffs. This small market grew rapidly (at about ten times the rate of growth of the population of Queensland), but it seems unlikely that the overall distribution of demand has changed much during the period. It seems likely that the threefold pattern of markets that can be seen today has been a fairly permanent feature. Greater changes in marketing have occurred in relation to the customers that use the cement and the transport used to serve these customers.

In the following section the growth of production at Darra to cater for the growth in demand will be described and changes in the supply or transport of materials explained. After this, the suitability of the location of the plant will be examined in the light of changed conditions of assembly of materials or of distribution of product.

2. EXPANSION OF PRODUCTION AT DARRA[1]

The initial capacity of the Darra plant when it came into operation in 1918 was 30,000 tons, but various technical difficulties prevented the plant from working to full capacity, and by June 1922 only 70,000 tons of cement had been produced. As will be seen from Graph 1, pre-war imports of cement from overseas had been of the order of 25,000 tons but from 1917-18 to 1921-22 only 1,000 tons were imported. The shortage resulted in a much higher price for cement. For example, in 1919-20 only 4 tons of cement were imported at a cost of £70, this being a sevenfold increase in price from the pre-war cost of a little over £2 per ton. These prices are values declared for customs purposes so the cost to the consumer would have been higher. Despite the absence of competition from overseas suppliers and the increase

[1] Information for this section has been obtained from various company publications and Annual Reports, from the R.S.B. "Investment Service", and from interviews with the General Manager of the company.

in price, the company sustained substantial losses in its first years of operations. The company earned its first trading profits in 1920-21 and in 1922 the capacity of the works was increased to 60,000 tons to bring production up to a more economical level. This increase in capacity was accomplished by improvement and extension of handling facilities without necessitating the construction of an extra kiln. During the succeeding six years the accumulated losses were extinguished.

During this period it became increasingly obvious that the most unsatisfactory link in the company's operations was the two hundred mile haulage of limestone from Gore near Warwick. Rail freight costs were high and supplies were often uncertain due to shortages of rolling stock, delays and breakdowns. In this period although the company produced up to 50,000 tons of cement annually, at the same time direct overseas imports amounted to from 5,000 to 8,000 tons annually. The company's high cost structure due to the expensive long haul of limestone and high rail freights limited the spatial extent of the market which the Darra plant could supply. Overseas cement was able to compete in northern coastal Queensland.

The Tariff Board's 1935 report stated that the transport of limestone from Gore to Darra was more expensive than the shipment of cement from Sydney to Brisbane (See Appendix 3). The report stated that the cost of railing the limestone was 19/- per ton (approximately one-quarter of the selling price of cement in Brisbane) and, although this may seem high, the New South Wales plants were faced with rail freights of between £1. 0.0. and £1. 5.0. per ton to transport cement to Sydney.

By the end of the decade, a coral and calcareous algal formation near Mud Island in Moreton Bay was brought to the company's notice. A survey by Professor H. C. Richards, Department of Geology, University of Queensland, was conveyed to the company in 1931, and verified the suitability of this deposit as a source of lime. However, this was a period of depression and the Queensland market for cement declined to one-third of its former size. No cement was imported for at least three years and local production was reduced seriously. The increase in the demand for cement was slow after the depression and the directors were understandably cautious about future market prospects. By 1936 the demand for cement had exceeded 60,000 tons annually and, when arrangements had been made for the dredging transport and works handling of the coral, a second 150 foot kiln was added to the plant increasing its capacity from 60,000 tons to 150,000 tons per annum. Since 1938 the company's cement has been made entirely from the new coral source. In the early war years the company produced and sold approximately 100,000 tons of cement per year, but by the end of the war was working to capacity (about 150,000 tons per annum). The new cost structure and the absence of competition[2] from overseas allowed the increased productive capacity to be fully utilized to capture the whole of the Queensland market and the increased market of the war years.

Because of the increasing size of the Queensland market the company realized that more expansion was needed but recognizing the geographic extent of this market decided against the full expansion being made at Darra. North Australian Cement Company Limited was floated as a public company in 1948-49 and a cement works with a capacity of 60,000 tons was built at Townsville.[3] However by 1951 the Darra plant was increased to a capacity of 250,000 tons by the addition of a third rotary kiln 350 feet long to the previous establishment of two 150 foot kilns. This expansion was to provide the needs of a growing market resulting from a growing population and an increasing per capita consumption for which new governmental development works and new uses for cement (e.g. concrete blocks) were partly responsible.

After 1951-52 when imports from overseas reached a peak of 54,000 tons, imports have declined rapidly and since 1957-58 there has been no significant entry of foreign cement into Queensland (except, of course for

---

[2] No cement was imported after 1940 until some 4,000 tons were imported in 1948-49

[3] See Chapter VII.

quantities - usually less than 1,000 tons p.a. - of special cements.)[4]

In 1956 a minor expansion to give a total of 300,000 tons capacity was made by a change from old to new plant seeking the economies of technical efficiency. A second 350 foot kiln was added and the small kilns were then used only occasionally.

During this period of expansion of production the company was able to make a significant expansion of its markets into Northern New South Wales. It was enabled to do this by several factors:

(i) because of its position this area is in many ways tributary to Brisbane;

(ii) Brisbane cement prices were, and still are, the lowest for any capital city in the Commonwealth since the favourable cost structure of the company gave it a low production cost. Cement from Darra was therefore better able to stand the increment in price due to transport costs;

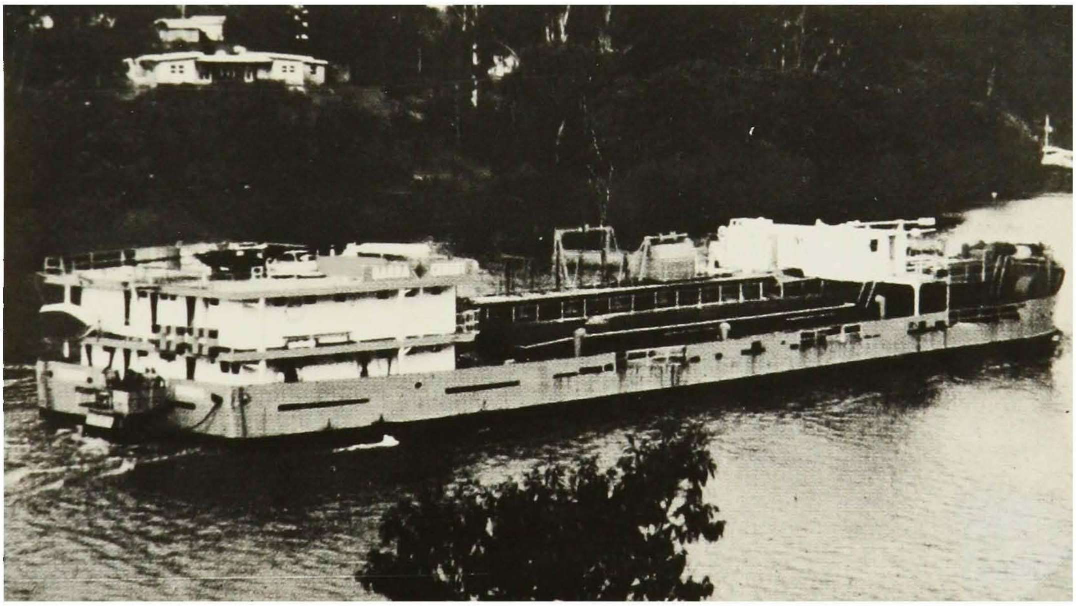
(iii) the New South Wales plants in general experienced a rather difficult time financially in this period. Plant had suffered from the ravages of the war

---

[4]In 1961 after the landing of 300 tons of cement at Cairns from Japan the two Queensland Companies made a concerted protest to the Tariff Board which found that the cement had been "dumped" and ordered a special tariff to be imposed. (See Chapter VII, Section 4.)

CORAL DREDGING AND TRANSPORT

MUD ISLAND, MORETON BAY.



M. V. CEMENTCO

(iii) contd.
years and the subsequent boom and was rapidly becoming obsolescent. Following this period all of the New South Wales works made major changes in plant. During this period the nearest competitive plant, that operated by the Sulphide Corporation at Cockle Creek, closed down;

(iv) the provisions of the Commonwealth Constitution as they have been interpreted regarding road tax, and the advantages of road over rail transport in serving this part of New South Wales, combined to make transport rates more attractive.

In 1960, the next large addition was made when a 465 foot kiln was installed and the two small kilns withdrawn from use. The capacity of the plant was then 500,000 tons per annum, but since the new kiln could supply 250,000 tons of this and as sales from 1959-60 to 1962-3 were of the order of 300,000 tons even the two 350 foot kilns are not fully utilized. However, this is desirable since the new kiln with its heat exchangers and generally improved design is far more efficient than the older ones.

During 1959-60 the two Queensland companies conjointly formed a new company, Central Queensland Cement Pty. Ltd. to market cement in the Rockhampton area. By April 1963, a grinding and bagging works had been built and began to grind clinker sent by rail from Darra and to produce cement. In early 1965 contracts were signed for the construction of the primary stages and kiln of a plant which would have a capacity of 100,000 tons per annum. The new plant began operations in November 1966.

During 1963-64, the Queensland Cement and Lime Company placed orders for additional equipment worth £1,500,000 to ensure that no "bottlenecks" in raw material supply occur, thereby to ensure the productive capacity of 500,000 tons per annum. This equipment includes a new cement grinding mill, a two mile long coral conveying belt to carry coral from the Brisbane River to the works and a coral carrying vessel.

At this stage it was not certain whether there would be any further extension to the size of the Darra plant. This was not because a further growth of the market in southern Queensland was not foreseen, but because of the attractions of an alternative site. The existing capacity of 500,000 tons was considered adequate until the early 1970's but then extensions will have to be made. These extensions will have to be of about 200,000 or 250,000 tons per year capacity due to the economies of scale necessary in modern plants. These extensions could be made at Darra but the company also considered the construction of a new works at Ormiston. This new site was thought to offer certain possibilities in fuel and raw material transport cost advantages, but it was also faced with certain legislative and social prejudice problems.

As will be explained later the company did not proceed with building at this other site. It is interesting to note in passing how this location compares with the prescriptions of the thesis proposition. The situation, within the Brisbane metropolitan area, would still be described as market oriented at this level. Access to the limestone (coral) source at lowest cost would limit the general situation to the coastline of Moreton Bay -- though of course location on the Brisbane River near its mouth would have served the same purpose. The exact site which was chosen was a suitable, available area of ground with access to clays, water and road transport. The ultimate reasons for its purchase were its availability and price because there were other blocks of land nearby with the same site requirements. However rail transport was not available and could not easily be provided.

By 1965 the property at Ormiston was being utilized as a base for the company's marine operations both in the winning and exploration of coral. Also coral was being stockpiled for transport to Darra by road in anticipation of demand at Darra being in excess of what the existing coral carriers were capable of transporting. The company's exploration revealed large deposits of coral in four areas and leases were obtained from the Queensland Government for the exclusive licence to dredge coral from St. Helena Island, the foreshores of Green Island, Raby Bay and the interior of Mud Island. In late 1966 and in 1967 coral was dredged from Raby Bay and trucked to Darra, an operation that in itself was completely uneconomic but that was necessary to keep the plant at peak production.

3. SUITABILITY OF DARRA FOR THE CONTINUED SUPPLY OF THE MARKET

In this chapter the nature of the Queensland market and the way in which it has changed over the years has been discussed and a brief outline given of the main developments that have taken place at the Darra works.

It is now necessary to examine further whether changing conditions of the past fifty years have changed the locational circumstances under which the plant was established, and to assess whether or not the original location has continued to be a suitable one. The fact that the plant is still in operation can not, by itself, be taken as evidence that the location is entirely suitable. The immobility of invested capital in plant and buildings tends to favour continuation of production at the same site until the unfavourable nature of the location raises the costs of production and distribution to such a level as to cause production at the site to be discontinued. Also the immobility of fixed capital will result in a continuation of production in a site simply because there is no significantly better site although several equally as favourable may exist. The position is further complicated when a company accelerates its depreciation charges in years of good profits and so has plant still in operation after it has been written off. The capital consumption charges are high in a capital intensive industry and the amount allowed for depreciation may equal up to 20% of the total of other manufacturing costs. This means that a company that had completely written off all equipment and that did not have to make allowances for depreciation could then afford to pay a penalty incurred by unfavourable location of up to 20% on costs of raw materials, fuel, labour and management. Obviously the margin of viability is broad in such a case.

Some of the major changes in the industry have been the changes in the markets and in marketing methods. As has been shown earlier the changes in the market have served only to reaffirm the suitability of the original location for the supply of the regional market. Related to the changes in the market are the changes in the transporting of the cement away from the works.

For the local market mainly road transport is used but the company considers that both rail and road transport facilities are desirable. This is obviously related to the extent of the market which the Darra plant serves. The mode of transport utilized depends on the customer, the destination of the product and the nature of the purchase. Almost all of the cement used within twenty miles of the plant (estimated at 50% of all sales) is transported by road, though some Queensland Government purchases are transported on the Queensland Government Railway as is the cement for the two large manufacturers of asbestos cement goods in Brisbane. For reasons explained above, the Northern New South Wales market is also served by road. Another reason is the break of gauge between Queensland and New South Wales. This would involve trans-shipment either at the Interstate Yards in Brisbane or at Wallangarra depending on the route taken. Altogether about four-fifths of the cement leaving the plant does so by road and half of this is in bulk form. As has been explained, the company sells directly only to large consumers and to wholesalers, the cement being transported by hire trucks to the wholesalers' depots. The company therefore has no direct concern with distribution, though of course, access for consumers to the plant is equally as important a site consideration as if the company was itself distributing its product.

Rail transport is used to serve two large bulk users of cement in the metropolitan area and customers in distant parts of the market area and to carry almost all of the Government purchased cement. Rail transport was also used to send clinker to the Rockhampton plant from 1963 to 1966. In major development projects (such as the Leslie or Nerang Dams in recent years) bulk rail transport has been the obvious choice. In a study of the transfer of cement by rail, referred to in Chapter VIII, it was found that there were at times unexpectedly large flows to small centres. The varying places of consignment reflected the temporary demand created in various areas by construction projects and this contrasted strongly with the stability of the demand generated by the manufacturing of cement goods. The following table summarizes the main places of consignment in the West and South-West over the three years. (Notice that the consignments to these three stations are in each year more than half of the total for the region).

TABLE 6

Consignments from Darra (to the nearest hundred tons)

Year	Toowoomba	Warwick	Cobba-da-mana	Total West and South West
1963-64	5,500	11,400	nil	29,700
1964-65	4,200	7,900	1,000	24,100
1965-66	5,200	3,000	6,400	23,600

As Toowoomba is a city of 50,000 people, Warwick a town of 10,000 and Cobba-da-mana a hamlet with a population less than 50, then it is obvious that each has been at some stage the focus of a strong temporary increase in demand. In each of these three cases there has been a water supply project in the area. Similar, but smaller scale, temporary increases in demand can be noticed at other centres and are associated with Public Works of more modest size. (See Appendix 4).

Only in the first of the three years investigated were there consignments to the South Coast. In 1963-64 8,700 tons of cement were consigned to Southport and most, if not all, of it would have been for the Nerang Dam project. However even the earning of £16,200 for this freight did not save the Southport line which had been declared uneconomic and it was closed on 1. 7. 1964.

Upon consideration of the marketing and transport requirements that have been outlined in this study as being mainly situation requirements, and consideration of the position and marketing and transport facilities of the Darra works it can be said that there was no significantly better situation for the plant. Consequently the company has no reason on these grounds to consider a major locational shift.

The factors of raw material supply will next be considered as these are the factors which define the situation more exactly. The changes in these factors have reinforced the attractions of the market oriented situation by providing an even lower cost solution to the problem of minimizing assembly costs on raw materials. However it must be said that though there is now a lower cost solution to the problem Darra does not provide the lowest cost solution. The effect of these changed supply factors will now be examined at the level of the more precise definition of situation and at the choice of site level.

Probably the most important changes in the location factors are those relating to raw materials and of these the greatest change has been that from limestone to coral. The Queensland Cement and Lime Company was able to improve the whole cost structure of its operations when it did away with the long rail haulage of limestone from Gore. The coral is dredged, transported by water up-river to the company wharf and taken from there by truck to the plant.[5] It will be noted that in Chapter V above, in the discussion of the 1914 location decision, there was no reference to the possibility of using the Brisbane river as a transport route. Thus it can be seen that although under the previous set of conditions location on the railway to the west of Brisbane

---

[5] Plans were announced in early 1964 for the construction of a conveyor belt to carry the coral from the wharf to the plant. Developments in Australian Manufacturing Industry, 1963-64, Department of Trade, Canberra, p.36. The two miles long cross country conveyor came into use at the beginning of 1967.

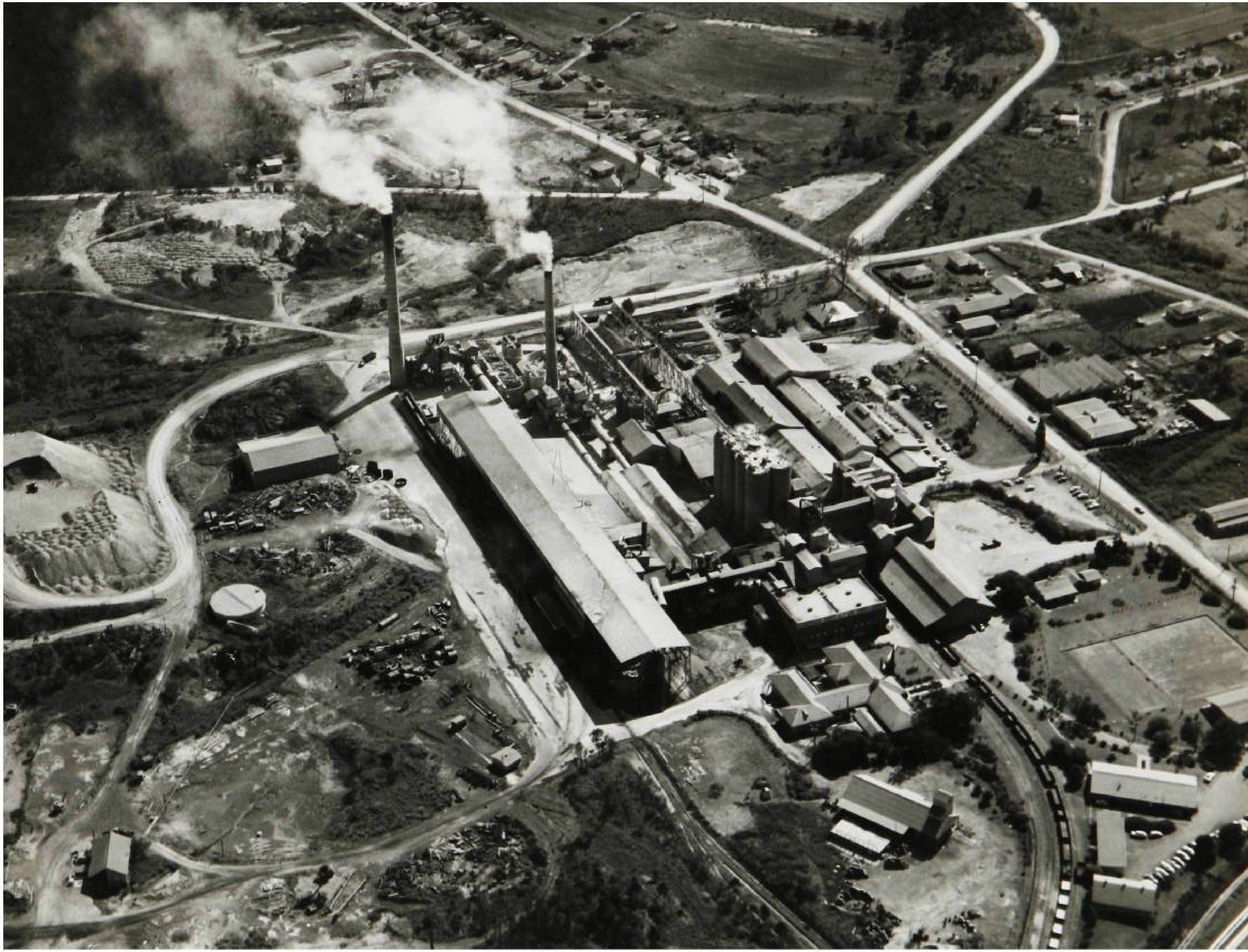
was desirable, the fact that the plant was close to the river by which coral could be brought 40 miles from Mud Island has been, to a large extent, fortuitous[6] and has made the site continue to be satisfactory. Its satisfactory nature is indicated by the fact that there has been a more than eight-fold increase in plant capacity from the "pre-coral" days until the present.

From 1949 until the beginning of 1967, six months before the end of the period covered in this survey, the Queensland Cement and Lime Company had a dredge stationed at Mud Island and two coral carriers. Each of the three vessels was originally an Army invasion vessel and each

---

[6] Only a few geographers have attempted an overall description of the distribution of industrial activity in Australia. One of the soundest and simplest is that by G.J.R.Linge, "The Location of Manufacturing in Australia", Chapter 2 of The Economics of Australian Industry, ed. A.Hunter, Melbourne University Press, Sydney, 1963. It is obvious however that Linge is wrong in describing the Darra plant as raw material oriented. "Limestone and cement factories are normally established close to a source of calcium carbonate such as ... coral (such as that dredged from Moreton Bay and used in the Darra works on the Brisbane River). (p.33).

If however the near-river site was fortuitous the near-Brisbane situation was deliberate market orientation. A site oriented to raw materials (coral) would not involve a 40 mile trip up river but, as has been explained, would be on Moreton Bay or near the river mouth.



The Darra Plant of the
Queensland Cement and Lime Coy.

has been rebuilt for its present function. Each is of medium draught (ten to fifteen feet) which is satisfactory for work in the lower Brisbane River. The larger of the two coral carriers, the "Cementco" is a particularly interesting vessel almost 200 feet long and able to transport 2,000 tons (wet weight) of coral. Her six screws and six rudders give a very desirable manouvrability for work in the restricted Brisbane River.

In order to increase the up-river transport of coral the company decided to purchase an additional vessel to carry 2,500 to 3,000 tons of coral per trip and capable of making two trips daily. The Australian Shipbuilding Board awarded the contract to Evans Deakin and Co. and the ship was launched late in 1966. During the last six months of the period under review the M.V. "Darra" transported coral to the extended Oxley wharf where a new crane and coral crusher and the belt conveyor were in use.

In the production of over 300,000 tons of cement in recent years, over 600,000 tons (wet weight) of coral has been carried each year along the forty mile trip from Mud Island to the Oxley Wharf. The need for a cheap route of bulk transfer is obvious and so the company was fortunate not merely to be near the Brisbane River, but to be near it at a point which could be reached by large vessels.

Changes in the types, and methods of use, of power and fuel supplies have been small during the half century of operations but there has been a big change in the importance of these requirements as location factors. In the original location decision the availability of electricity was a restricting factor, as was the need to be on the railway line to the west of Brisbane in order to have low cost access to coal from the West Moreton field. Today both of these sources of energy may be regarded as ubiquities for a plant locating in the general Brisbane area. In the case of coal the Queensland Coal Board sets the price and usually gives instructions as to the supplier. Further this means that economies in fuel can not be gained by bargaining for a lower price or by contracting with a company for a given price. Economies then can only be gained by technological improvements, e.g. "heat economies". Another consequence is that the supplier of coal is usually the mine or mines closest to the consumer. At present the Darra works are supplied from the Rylance mine at Dinmore and from the Rhondda Mine, and from both of these all of the coal required comes by road. Under such a controlled system of production and pricing coal loses its importance as a locating factor.

However as mentioned above it was thought likely in 1963 that the future development of the Darra plant would depend on the possibilities for development at Ormiston. One of the possibilities was that it might have been possible to use heavy residuals from the Ampol Oil Refinery at Lytton which was then under construction. This, however has not been the case.

The electricity used at the plant is purchased from the Southern Electric Authority. Being able to purchase electricity instead of having to generate it is, in one sense, what Isard has called an urbanization economy (an economy effected by location near an urban area - a type of external economy of scale). However the wide area over which the Southern Electric Authority grid extends means that electricity may now be treated as a ubiquity in any location analysis within this area.

Although the changes in the locational pull of the energy sources do not favour the continuation of production at Darra, neither do they indicate any necessity to shift to another site.

Only minor changes have occurred in the supply of other raw materials. The argillaceous and arenaceous materials are still obtained from the weak tertiary shales, the clays and the sands that are found on and near the works site. In 1966 the company purchased an area of land close to the works to ensure the company's requirements of clay for future years, and as well entered into a contract with the State Department of Forestry for the rights to obtain sand from nearby crown land.

For the iron bearing material which is required for admixture to the slurry whenever analysis shows that it is necessary, the company utilizes the residue from A.C.F. and Shirleys Fertilizers Pinkenba works. This item is an insignificant component of the final cost, and as its cost would not vary significantly in the

Brisbane area it can be ignored as a site determining factor. The gypsum used as a retarder is purchased in bulk from Stenhouse Bay in South Australia and arrives at the port of Brisbane by sea. In recent years the company has used annually some 12,000 tons of gypsum. Although the gypsum represents a more significant component of the final cost than the iron its cost would not vary greatly within the Brisbane area and so it also may be ignored as a location factor.

The present scale of production at the Darra plant involves an annual consumption of over 60,000,000 gallons of water. As this is only equal to Brisbane's consumption of water on a summer day it would impose very little strain on the Brisbane City Council's water supplies if it had to be purchased. However, in the present location the water can be drawn directly from the Brisbane River.

The total labour force involved in the production at the Darra works is about 470 - a not inconsiderable number but one which can easily be obtained at a location close to any large town in the state. The labour requirements are not highly demanding with respect to skill of labour and the labour costs represent only about 15% of final production costs. Even this percentage could be significant if labour costs showed a high degree of areal differentiation in Queensland. However, under the present arbitration system wage level variations can be considered as insignificant as a location factor. Of greater areal differentiation, and therefore greater significance, would be costs other than wages involved in

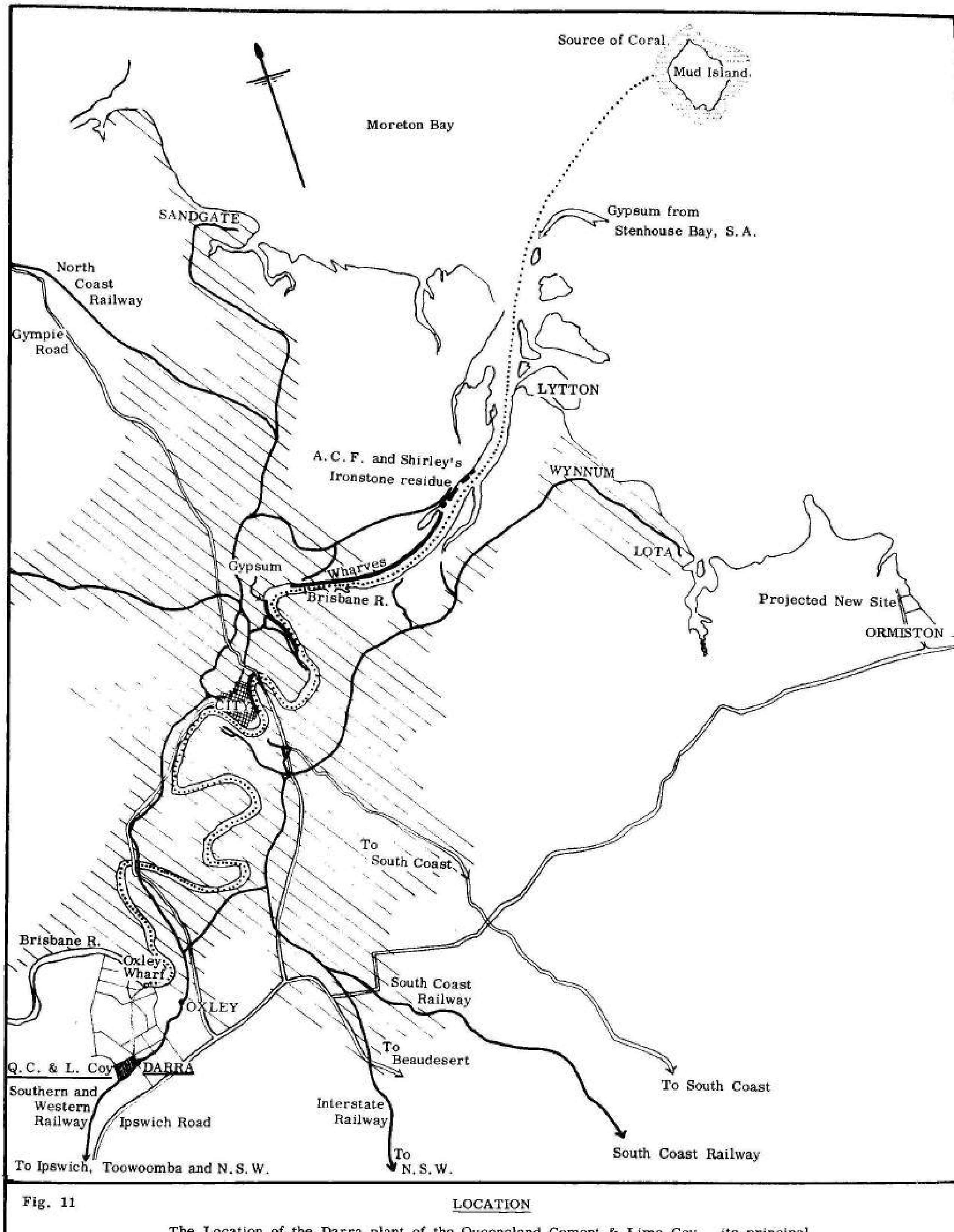
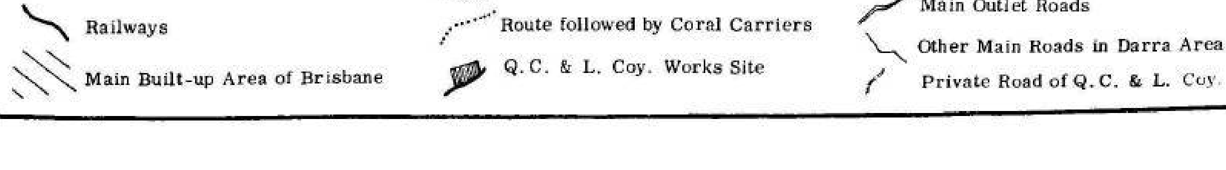
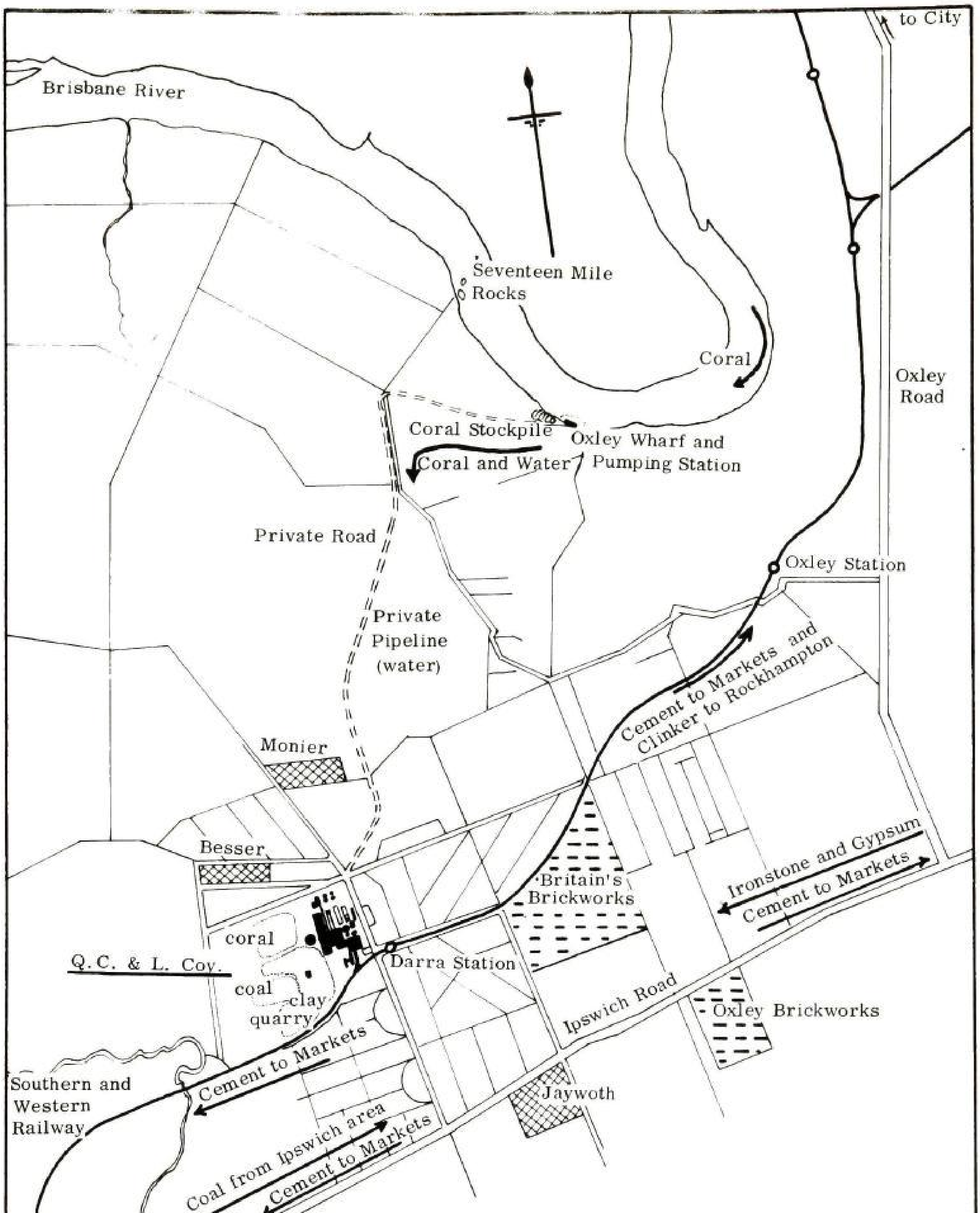


Fig. 11

LOCATION

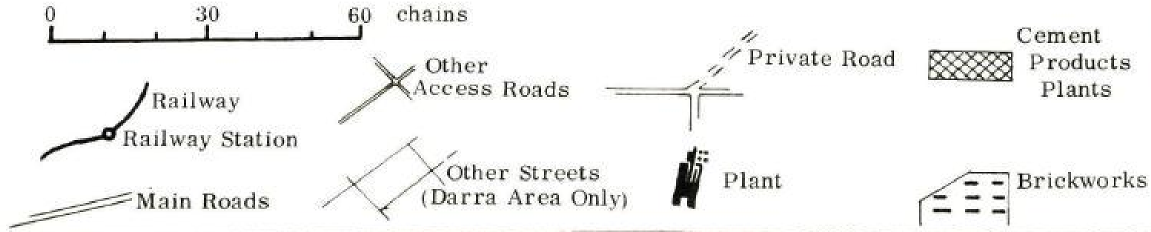
The Location of the Darra plant of the Queensland Cement & Lime Coy., its principal market, the source of its most important raw materials and the major transport routes.





SITE

The site of the Darra plant of the Queensland Cement & Lime Coy.: its road and rail transport facilities, the movement of materials and product, the utilization of the site by the company, the location of certain industrial users of cement near the plant and other clay quarrying industries of the area.



obtaining labour. These costs could arise from the need to provide housing or other facilities if the plant were located in a remote and isolated area, but for any location in easy commuting distance of Brisbane such considerations do not arise.

A consideration of capital as a location factor involves two aspects of capital only one of which is significant. First the capital market in Australia is nation-wide so fluid capital can be regarded as completely mobile, or as a ubiquity in the regional location decision. On the other hand fixed capital in plant and machinery is almost completely immobile and, for the reasons outlined on pages 156 and 157, tends to cause production to continue at an established site.

The only other factors which it is felt could be of importance are legislative and social factors. No municipal zoning ordinances existed when the Darra plant was established but since that time other industry has sprung up in the Darra area which is now firmly established as an industrial area. Although the present city planning ordinances are not a positive factor for the continuation of location at Darra, they could conceivably become so in the event of the company wanting to shift to a new location. Related to these legislative factors are the social attitudes which give rise to them. Objections were raised in 1963-4 by local residents concerning the company's proposals for the Ormiston works. In the past cement works have been notoriously objectionable because of the dust from the kilns. However the ash at the Darra works is electrostatically precipitated and this could presumably be done at a new site. But, regardless of whether the social attitude is justifiable or not, it can be definitely stated that a company would be distinctly limited in its choice of location by the existing social prejudice against the industry.

In summary then it can be said that the situation of the plant has remained satisfactory as the plant is still in the general area of the main focus of the Queensland market. However it can also be stated that technological advances have freed the Queensland Cement and Lime Company from some of the restrictions involved in the original location decision. Fixed capital immobilities set aside, the company is now less tied to the Darra site. However, as it continues to be favourable and as there is no real incentive to shift from Darra, the immobility of fixed capital should result in a continuation of production at the present site. On the other hand, <u>if</u> economies of fuel and raw material transport costs could balance the dis-economies of smaller production, the company would be free to establish extra capacity elsewhere. This possibility alone does not seem likely but there is a greater likelihood that the company could attain economies in distribution to help to balance the dis-economies of smaller production. This could result from greater proximity to some new concentration of demand within the Greater Brisbane area. The area of Brisbane with the greatest planned industrial development is the area near the river mouth and for this region a bayside location for a cement plant could be desirable. However at the end of 1967 the company plans were for a 250,000 ton increase to be made at Darra.

In January 1968 Mr. G. Walker, the new Manager of Queensland Cement and Lime Company, stated that in the decision to expand production at Darra instead of building at Ormiston, economic considerations far outweighed any social or legislative factors. He claimed that access to markets was the most important of the economic considerations involved. Earlier in this section it was pointed out that half of the market for the company lies within twenty miles of Darra and is served by road. It can be noted that a twenty mile circle around Ormiston takes in no significant new territory and that at least half of the area lies over Moreton Bay and its islands.

It now seems certain that, for the foreseeable future at least, the only cement plant in south-eastern Queensland will be at Darra.

TABLE 7.

PRODUCTION OF CEMENT IN AUSTRALIA AND IMPORTS OF CEMENT INTO AUSTRALIA, 1904-1967

Year	Production '000 tons	Imports '000 tons	Year	Production '000 tons	Imports '000 tons
1904	n.a.	28	1936-37	720	15
1905	n.a.	35	1937-38	852	12
1906	n.a.	40	1938-39	868	9
1907	n.a.	26	1939-40	865	3
1908	n.a.	46	1940-41	860	-
1909	n.a.	42	1941-42	890	-
1910	n.a.	81	1942-43	730	1
1911	n.a.	83	1943-44	693	3
1912	n.a.	130	1944-45	694	-
1913	n.a.	125	1945-46	723	-
1914-15	n.a.	70	1946-47	882	-
1915-16	n.a.	76	1947-48	1,013	2
1916-17	n.a.	8	1948-49	1,031	34
1917-18	n.a.	-	1949-50	1,167	92
1918-19	n.a.	n.a.	1950-51	1,235	46
1919-20	n.a.	6	1951-52	1,237	104
1920-21	n.a.	27	1952-53	1,439	106
1921-22	n.a.	24	1953-54	1,700	56
1922-23	n.a.	44	1954-55	1,920	138
1923-24	492	29	1955-56	2,035	27
1924-25	578	26	1956-57	2,173	9
1925-26	605	23	1957-58	2,291	3
1926-27	638	19	1958-59	2,481	4
1927-28	754	23	1959-60	2,632	9
1928-29	708	22	1960-61	2,860	7
1929-30	697	14	1961-62	2,781	9
1930-31	389	-	1962-63	2,942	12
1931-32	247	-	1963-64	3,322	12
1932-33	321	1	1964-65	3,746	43
1933-34	410	2	1965-66	3,680	45
1934-35	550	5	1966-67	3,648	23
1935-36	645	14			

CHAPTER VII

GEOGRAPHIC DIVERSIFICATION WITHIN THE CEMENT INDUSTRY

1. GROWTH OF NEW MARKET CONDITIONS

During the war years and immediate post war years, cement production for the whole of Australia declined and imports were negligible. The main reason for the decline in production from 1941-42 to that in 1944-45, was the difficulty experienced in keeping plant and machinery operational. However the Darra plant, which had undergone expansion of capacity and had changed to the use of coral immediately before the war, had not the same difficulties as some of the older plants in New South Wales. Production of cement in Australia did not exceed the 1941-42 totals until 1947-48, and in this year the production was 10% above the previous figure. However the Darra plant in the same time had expanded production just over 50% and was producing to capacity (150,000 tons). This high, and highly profitable, level of production was maintained until 1951 when the capacity of the works was further increased.

During this period, demand continually exceeded supply. The entire Queensland production of cement was used within the State except for small amounts (in all years less than 200 tons) exported to Australian Territories and the Pacific Islands. It was not possible to obtain imported cement until 1948-49 and in the immediate post war years the shortage was acute, even public works being affected.

Some record of the shortage, which occurred in the supplies of almost all building and constructional materials, can be found in the debates and questions of the Queensland Legislative Assembly. In this time one of the members who was most persistent in raising this question in the house was Mr. Aikens, the member for Mundingburra whose electorate includes much of Townsville.[1] This would seem to indicate that the shortage in North Queensland was more acute than elsewhere in the State. On one occasion Mr. Aikens had to make representations to the Minister concerned on behalf of a local authority for a supply of cement to complete vital works before the onset of the wet season.[2] On another occasion Mr. Aikens' question was merely an attempt to bring to the notice of the government the "delays being caused in North Queensland due to the cement shortage." On this occasion the Hon. E.M.Hanlon replied that "delays were being caused in North Queensland, Central Queensland and Southern Queensland"[3] indicating the widespread nature of the situation.

As early as 1946, suggestions had been made regarding the construction of a cement plant somewhere in north Queensland. In August 1946, Mr. Decker, the member for Sandgate, had asked "has any approach yet been made to the government by the local authorities concerned for technical and financial assistance in establishing a cement works to service North Queensland?" and "would the government be sympathetic to such a request."[4] However the reply was that it was not the

---

[1] Queensland Parliamentary Debates, Vol.CLXXXVIII - 199, 1946 to 1950-51.

[2] ibid Vol. CLXXXVIII, 1946, p.1236

[3] ibid Vol. CLXXXIX, 1947, p.198

[4] ibid Vol. CLXXXVII, 1946, p.112

government's practice to announce matters of policy in reply to questions, and no further record can be found of this interesting suggestion in the parliamentary records or in the local press.

In 1948-49 the first overseas supplies of cement became available. Of the 4,000 tons imported in that year almost 1,500 tons were imported directly through the ports of Cairns and Townsville, but there is no record of any amount imported elsewhere and redistributed to north Queensland.[5] The following year, 29,303 tons were imported and this amount, together with the production from Darra, made a total supply for Queensland of over 180,000 tons. Cement sales in and north of Mackay totalled almost 33,000 tons (see Tables 3 and 8).

2. THE NEED FOR INCREASED CAPACITY

As has been stated the plant at Darra was producing to capacity, the demand for cement exceeded the available supply and it was certain that the market for cement would continue to expand. The Queensland Cement and Lime Company recognized that extra capacity was needed and planned by 1951 to increase the capacity of the Darra works by the instalment of its first 350 foot kiln. The company apparently also recognized that cement works in North Queensland would be able to serve that market with less cost of transport. However it can be suggested that the company was also motivated by the need to inaugurate the establishment of a plant so as to prevent an opposition project being established in the area.

[5] ibid Vol. CXCVI, 1950, p.1480 and Overseas Trade, 1948-49, Commonwealth Bureau of Census and Statistics, Canberra, 1949.

This suggestion is based on four sets of facts. First, the north Queensland market in 1949-50 did not exceed 33,000 tons and the market for the whole of Queensland north of Gympie did not exceed 46,000 tons per annum. Secondly, the company's investigations as early as 1948 were based on the possibility of establishing a plant of 60,000 tons capacity. Thirdly, the plant was not brought into production until the end of 1954 and this lengthy period for establishment was publicly queried at the time.[6] Finally in the new company's first full year of production, the plant produced almost to the planned capacity of 60,000 tons. Actual sales were 58,524 tons and the following year sales were made of 69,241 tons plus an extra 3,995 tons which had to be drawn from the Darra plant.

From a consideration of these facts it seems that the Queensland Cement and Lime Company had accurately forecast the size of the North Queensland market in 1954 and that the plans to establish a plant were based on this forecast. Thus it also seems that the claim made above is not an unfair one and that the Queensland Cement and Lime Company proposals in 1948 were as much motivated by the need to forestall competition as by the need to establish a plant.

This issue has been raised not as an opportunity to discuss the ethics of business competition but in order to clarify the position with regard to the first proposition

---

[6] Mr. Low questioned in the house thelength of time proposed for the establishment of the plant. He quoted two current projects of similar capacity, one in N.S.W. and one in New Zealand, which were to be in operation within 18 months. Queensland Parliamentary Debates, CXCVII, 1949, p.1562.

being argued here. As has been stated in Chapter IV production costs can only be minimized when the plant is working to capacity, and this is of particular importance in this case involving the establishment of a small scale plant in a regional market being supplied from outside sources. The judgment of the Queensland Cement and Lime Company is vindicated by the fact that the plant, when it came into operation as planned, was able to produce cement economically and substantial reductions in the price of cement in North Queensland were able to be made.[7]

Thus although the plant was projected as early as 1948 when the market was much smaller, its actual establishment was not completed until 1954 when the local demand was established at what the company considered a sufficient level -- the level for which it had planned a plant that could produce at a price which could be competitive. The delay in bringing the plant into production meant the loss of sales to overseas suppliers in the period from 1950 to 1954 of over 110,000 tons. This delay and surrendering of markets is understandable when it is realized that neither a small scale plant nor a plant working well below capacity could compete at the existing price. This supports the first proposition of the thesis that an adequate level of demand determined by the prevailing price was required before a plant could be

[7]The first full year of production was 1955-56. In January, 1959, and again in August 1959 the company reduced the price of cement to consumers, by 10/- per ton each time. In late 1960 the company made a further reduction of 10/- in the selling price of cement at Stuart. Investment Service, Research and Statistical Bureau, Sydney Stock Exchange, N54.

established.

As indicated above, and detailed in the previous chapter, the Queensland Cement and Lime Company planned to increase capacity from 150,000 to 250,000 tons in 1951. To finance this expansion it issued, in December 1949, 245,061 20/- ordinary shares to its stockholders. With this need to call for capital for the planned expansion of the Darra works the company did not wish to finance alone the projected North Queensland plant. Consequently it proposed to the government that a new company be formed to which the government would guarantee a loan and for which the Queensland Cement and Lime Company would act as supervising engineers and consulting chemists until the plant was established. The company also decided to maintain a substantial holding in the newly formed company.

3. THE LOCATION DECISION FOR THE NEW PLANT.

In evaluating the location decision for the Stuart plant a statement by the company is available that is more definite and authoritative than was the case for the Darra plant. From this statement made during the period of the establishment of the plant we learn that "the chief factors which caused the selection of Stuart as the site for a new works were :-

1. An annual consumption of cement in the area north of Mackay, which would be supplied by a works at Stuart, sufficient to support a works economically;
2. The availability of an excellent area of land on which already existed buildings, railway sidings, and roads suitable for use in a cement works;

3. Proximity to ample supplies of the raw materials required for the manufacture of cement;

4. Suitability for distribution, Stuart being at the junction of the north-south and Mount Isa railway lines and only six miles from Townsville."[8]

No attempt has been made in the above statement to rank these factors in order of priority, but this is as would be expected. The statement is merely describing the advantages of the site, the selection of which in practice is arrived at by an approximating process which it would have been involved to explain, and which was not really relevant to the purpose of the statement. This study on the other hand is concerned with the process of selection in which the general situation was chosen first. This step was necessary otherwise an infinitely large number of sites throughout the market area would have had to be considered. Discussion with officials of the companies concerned confirmed that the order of priority suggested in this thesis is correct. The procedure involved in making the location decision will now be described in more detail.

The starting point must be a consideration of the size and form of the regional market in which the new plant was to be placed. Information on these matters is available in considerably more detail than was available for the study of the Darra location decision.

---

[8] History, Production and Utilization of CEMENT in Queensland, Queensland Cement and Lime Company, 1951, p.13.

The market area was a very large one taking in all of Queensland north and west of Mackay. However the distribution of settlement in the area meant that demand was effectively concentrated in a triangular area with a base of some 450 miles stretching from Mackay to Cairns and with its apex at Mt. Isa some 600 miles inland from Townsville. Townsville at the junction of the Great Northern Railway and the North Coast line was the largest city and occupied a central position on the base of the triangle. Although there are no figures for the actual distribution of cement consumption the Queensland Cement and Lime Company had compiled figures of cement sales for the main centres and along the stretches of railway line between them. These are shown in the table below and the second column of the table shows calculation of the percentage of the total market in the different centres.

TABLE 8

Recorded Cement Sales in North Queensland 1949-50.

	Tonnages	% of total Sales.
Mackay	5,147	16%
North of Mackay	831	3%
Townsville	15,919	48%
North of Townsville	1,008	3%
Cairns	4,432	13%
Tableland	196	1%
West of Townsville	472	2%
Mt.Isa & Cloncurry	4,721	14%
TOTAL	32,726	

NOTES.

(i) These figures were supplied by Mr. L.J.Jones in 1964, and are based on tonnages handled by distributors in the various centres.

(ii) Company figures published in 1951 show the total as 32,747 tons but show for Mackay only 3,256 tons.

(iii) These figures include the 21,642 tons of imported cement sold in North Queensland out of the total 29,303 tons imported into Queensland.

It would probably have been better to have the figures for 1948-49 which was when the decision was actually made. On the other hand only 3,826 tons of cement were imported in 1948-49 and there was a great deal of unsatisfied demand so that these figures may give a better picture of the distribution of demand.

From the table the main features of the spatial distribution of the market can be seen. Obviously with this pattern and the existing railway system a location close to Townsville would be a central one from which to serve the market. Provided then that the required raw materials and fuel (particularly the limestone and coal) could be assembled satisfactorily, a site could be found for the works. It can be demonstrated by a consideration of market distribution and freight rates that a situation near Townsville not only is a central one but is the one that would provide lowest cost access to the whole of the regional market.

The second point that must be considered is the nature and level of the freight rates in the area because it is costs and not merely distance that separates segments of the market. The following table based on figures from the Queensland Government Railways Rate Book for 1948 makes obvious the relationship between the "M" rate under which limestone would travel and the "A" rate which would apply to the carriage of cement. For all distances over 20 miles it would be cheaper to transport cement rather than limestone even if low-grade limestone were being used. With the use of high-grade limestone where as little as 120 tons are needed per 100 tons of cement then for all distances it would be cheaper to transport the limestone than the cement.

TABLE 9

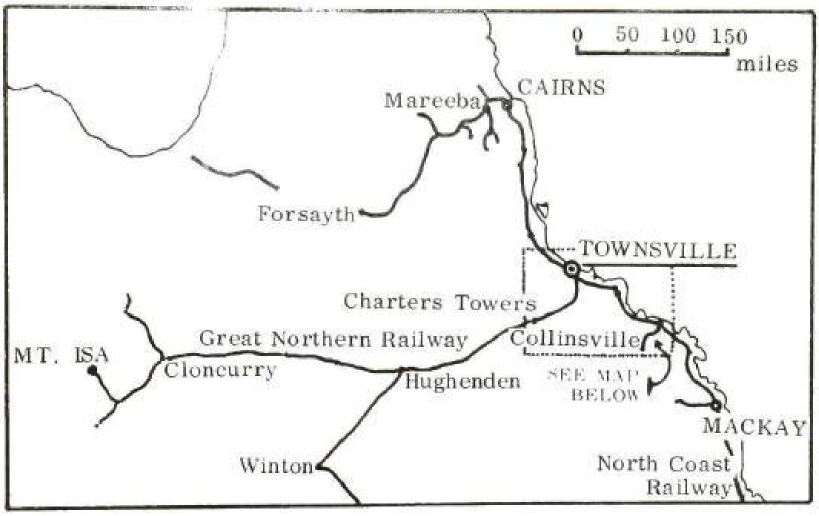
Relationship between Rail Freight Rates in 1948.

miles	(i) M s d	(ii) A s d	(iii) $\left(\frac{A}{M} \times 100\right)$ %
1-10	4. 6	6. 0	133%
15	4. 9	6. 9	142%
20	5. 0	7. 6	150%
25	5. 6	8. 6	155%
50	7. 9	13. 0	168%
75	11. 0	17. 9	170%
100	14. 3	22. 6	158%
150	18. 9	29. 9	159%
200	24. 0	34. 9	145%
400	34. 6	52. 3	151%
600	45. 9	69. 9	152%
800	57. 0	87. 3	153%
1000	68. 3	104. 6	153%

There is no need to repeat here the arguments which show that the lowest delivered cost of the cement depends on minimizing transport costs on the distribution of the cement. Given the above conditions of market distribution and freight costs it is apparent that the situation of the plant would have to be in the Townsville area. The supply of raw materials must now be considered to more precisely define the location of the plant.

A suitable deposit of limestone was available near the Calcium rail siding 34 miles from Townsville on the Mount Isa railway line. The deposit was 2 miles by road from the Calcium siding. The location of this deposit near Townsville was extremely fortunate as the only other suitable deposit known to the company was on the Atherton Tableland. If a deposit had not existed near Townsville the conflict between raw material transport costs and market orientation would then have been a most interesting one. The difference to the cost structure of the proposed plane engendered by the long rail hauls for either limestone or cement would probably have meant that a plant could not be constructed until the demand for cement in North Queensland was much greater. More probably though, further examination would have been made of the possibilities of using coral, of which there are known deposits near Townsville and for the use of which the Queensland Cement and Lime Company could offer invaluable information gained from its own experience. Detailed surveys after the establishment of the plant indicated that the limestone deposits though still adequate are less than previously thought. The possibility of a future usage of coral exists but there are many problems. The coral is alive, unlike the Mud Island deposits, and the problems of the smell nuisance it would create and the problem of salt removal are serious obstacles to its utilization.

Fig. 13

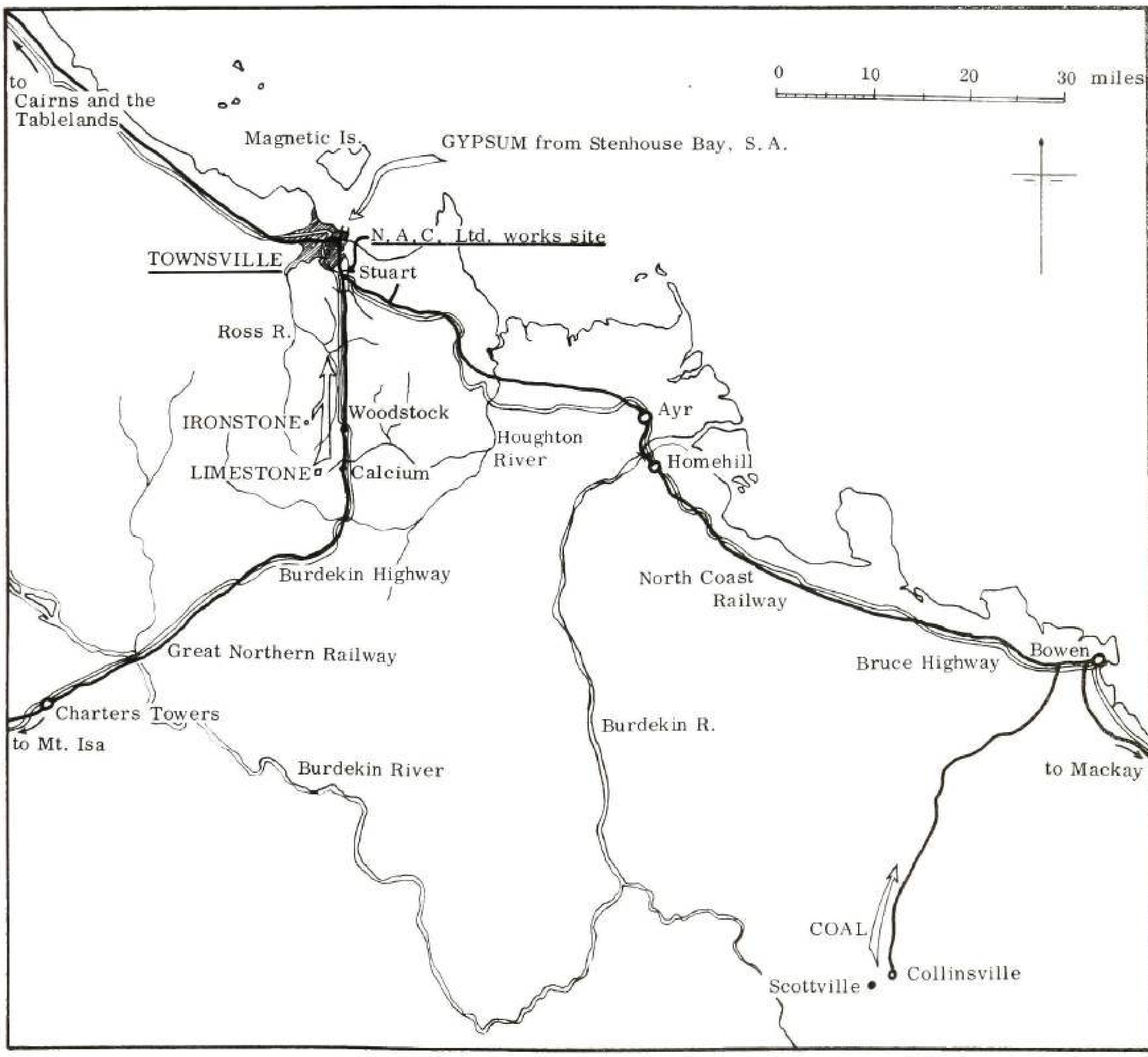


LOCATION

of the North Australian Cement Ltd. works at Stuart.

The market it serves and the main transport routes.

Sources and movements of raw materials.



The source of coal chosen was the Bowen Consolidated (subsidiary of Mt. Isa Mines) open cut mine at Collinsville. For a production of 60,000 tons per annum approximately 13,000 tons of coal would be needed and, for a production of 100,000 tons, some 22,000 tons of coal would be required. The chosen source of fuel involved a rail haulage of over 200 miles to the Townsville area adding considerably to the delivered price of the fuel. However this large generation of rail traffic and the revenue it created for the Queensland Government would have been one factor of considerable benefit to the company when it sought tariff protection in 1961 against the dumping of Japanese cement in north Queensland (see pages 194 & 195). Against this "tactical" reason for the use of coal however must be weighed the economic reasons for using fuel oil which apparently would be a less costly source of power. However as active government assistance was to be obtained during the establishment of the plant coal was used as the primary fuel.

At this stage the location problem was narrowed considerably by this setting of the parameters of primary market orientation and sources of coal and limestone. Given first the necessity of locating near Townsville, the limestone to come from Calcium on the Great Northern Railway and the coal to come from Collinsville along the North Coast line, the problem was to define more exactly the situation where transport outlays could be minimized while still being consistent with other locational requirements.

At this point the reasoning followed by the company seems to have departed from the deductive process followed so far. Instead, as the site eventually chosen for the works was available and was obviously attractive, it was tentatively chosen and its advantages and disadvantages balanced against those of other possible sites. The junction of the North Coast Line and the Great Northern Railway is at Stuart, six miles to the south of Townsville. At this junction was an available site with sidings and buildings which could be utilized and with water, clay and electric power readily available. Some of the advantages of the site as seen by the company have already been enumerated on pages 178 and 179.

The main focus of the market was Townsville and the major axis of the market lay along the coastal strip with the minor axis following the railway line to Mt. Isa. A position on the North Coast Line on the southern outskirts of Townsville would be able to serve this market efficiently and would be conveniently located for the assembly of the coal and limestone both of which were available to the south of Townsville. Given the relative weights and distances involved, location at the source of the limestone is yielded as the minimum outlay point for the assembly of the coal and limestone. But, as a result of freight structures, the primary orientation of the industry is to markets and not to raw materials, and only 15% of the market lies beyond Calcium along the route through the minor axis of the market. The other 85% of the cement would have to be transported to the junction at Stuart from where 70% would have to be transported to Townsville and further north. Further, location at Calcium, 34 miles from Townsville, would raise additional problems, the main ones being related to the availability of labour and the need for close, direct contact with the "consumers".[9] The labour and product distribution problems can be overcome, total costs of assembly and distribution minimized and various "urbanization" economies gained by location in the general area near the main focus of the market within ten miles of Townsville. Although this location does not minimize assembly costs for raw materials, the need to limit such transport outlays would still operate to prohibit unnecessarily long haulage of the limestone.

The choice of locations is then narrowed to a small area close to the existing rail lines within three or four miles of the junction at Stuart. To go further north than this area would be to enter the already closely settled Townsville urban area. To go further south than this would be to lose the advantages in labour availability and marketing given by a near urban site. But within this area, provided a suitable area of land with clay and water supplies could be found, then the plant could be constructed without any significant difference to the cost structure of production.

---

[9] The consumers of cement as far as the operators of the works are concerned are not necessarily the final users of the cement but those to whom the company sells - the big users and wholesale distributors.

The available land at the junction at Stuart between Stuart Creek and the main road and railway line, with already laid spur lines and available buildings and with alluvial clay and sand deposits and power and water supplies, must have appeared as the most favourable site in the area.

4. THE ESTABLISHMENT AND DEVELOPMENT OF THE STUART PLANT

"In July 1948 the Queensland Cement and Lime Company completed a definite proposal for the erection of a cement works at Stuart, which proposal was strongly supported by the Queensland Government, and resulted in North Australian Cement Limited ... going to allotment on 21st July, 1949".[10] Three-fifths of the original capital was provided by four large companies[11] and the government of Queensland guaranteed a loan of £200,000 arranged by the company with the National Bank of Australasia Limited.

The company which owned the limestone deposits at Calcium and which had treated and marketed crushed and burnt limestone of all types for many years was acquired by North Australian Cement Limited. Under the supervision of the Queensland Cement and Lime Company Limited construction at Stuart was commenced in

---

[10] History, Production and Utilization of CEMENT in Queensland, Queensland Cement and Lime Company Ltd.,1951,p.13.

[11] Of the first issue of 500,000 20/- ordinary shares, 120,000 were taken by Queensland Cement and Lime Company Ltd., 120,000 by Adelaide Steamship Co.Ltd., 25,500 by Mt.Isa Mines Ltd. and 25,000 by Goliath Portland Cement Co.Ltd. (operating works in Tasmania). Investment Service, Research and Statistical Bureau, Sydney Stock Exchange, N54.

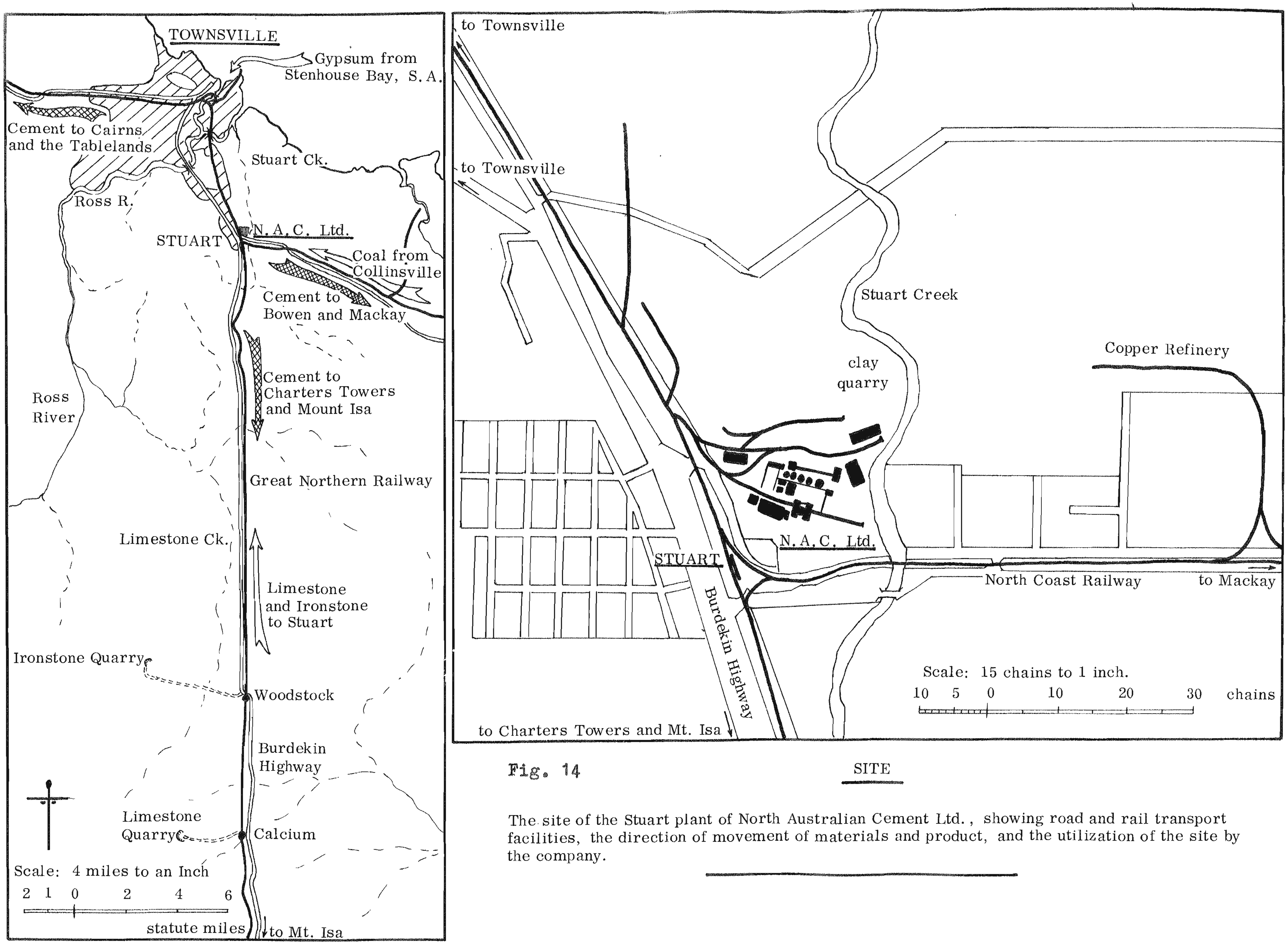


Fig. 14

SITE

The site of the Stuart plant of North Australian Cement Ltd., showing road and rail transport facilities, the direction of movement of materials and product, and the utilization of the site by the company.

1949. The company then began the erection of a cement-brick making plant which was completed in September 1952 and which proved very useful in the company's building programme. The company was then able to trade in lime and cement bricks (made with cement from Darra) before it began the production of cement.

The extent of government co-operation is seen in the fact that the government guaranteed a loan of £30,000 from The National Bank to finance the brick plant scheme and in 1953 guaranteed an additional bank overdraft of £250,000. This extra capital was needed because the substantial rises in costs in Australia from 1949 onwards had greatly increased the cost of installation of the plant at Stuart above the original estimated £600,000. Even then in June 1954 the company needed further capital and offered for subscription a further 200,000 shares. The final cost of the project was in excess of £1,200,000 and consisted of a cement works and cement brick plant at Stuart and a limeworks and crushed metal plant at Calcium. The production of cement finally began in October 1954.

During the following years the company operated very successfully. Production rose from 58,524 tons in the first year of operations to 76,009 in 1957-58. This increase in production had been made possible by the installation of a calcinator[12] in the kiln. In the

[12] A calcinator consists of a grate enclosing steel bodies which dries the slurry entering the kiln and catches dust. It increases efficiency and output, the exhaust gases leaving the kiln with a temperature of 230F instead of over 500F. In other kilns, e.g. at Darra, festoons of chains in the kiln serve a similar purpose.

next year the company was able to reduce the price of cement by 10/- per ton. In the first years of operation the company had not set an independent price but had sold at the prices set by the Queensland Cement and Lime Company. By the end of the following year two more similar reductions in price had been made. The company ceased production of lime in 1959 and the production of cement bricks in 1961.

The extent of government assistance at the formation of the company has already been outlined. Indirect assistance in the form of large orders for governmental projects was also important to the company: the construction of the Tinaroo Falls Dam, for instance, took almost 65,000 tons of cement or the equivalent of a whole years production. Until June 1963 the company produced almost 620,000 tons and of this government financed purchases accounted for at least 180,000 tons or almost 30 per cent.[13] (see Table 10).

---

[13] As indicated earlier it is almost impossible to obtain complete figures for government financed purchasing of cement. The figures stated here were released by North Australian Cement Limited to whom grateful acknowledgment is made; and apply to major government departments and to two private contractors (1) Ford Bacon and Davis engaged on the Mt.Isa Rail project and (2) Transfield Corp. engaged on the Barron Falls project dam on the Barron River. The figure of 20,000 tons for the bulk terminals is based on the fact that the Cairns terminal took 5,032 tons and the Mackay terminal 4,400 tons. No record is made of local Government purchases.

TABLE 10.

GOVERNMENT PURCHASES OF CEMENT IN NORTH QUEENSLAND.

	Tons
Total sales by N.A.C.Ltd. 1954-55/1962-63	614,502
Purchases by: (Total to June 1963) Irrigation and Water Supply (Tinaroo)	64,057
Main Roads	31,743
Co-ordinator General's Dept. (Koombooloombah, Kuranda)	26,420
Railway Department	8,307
State Electricity Commission	2,991
Ford Bacon and Davis (Mt.Isa Railway)	17,305
Transfield Corp. (Barron Falls)	10,729
Bulk Sugar Terminals (estimated)	20,000
TOTAL:	181,552

The importance to the new company of such a large market should not be underestimated. At the same time however the contribution of the company to the development of Queensland must also be recognized. The largest private purchaser of cement by far was Mt.Isa Mines Limited whose developmental works at Mt.Isa and at the copper refinery at Stuart used over 40,000 tons in the period up to June 1963. During this same time sales to various concrete products firms (other than ready mixed concrete) totalled only 20,000 tons. Thus it can be seen that the structure of the North Queensland market is very different from that served by the Darra plant, the main differences being the increased size of the government sector and the decreased size of the concrete goods sector of the market.

The Stuart Plant of
North Australian Cement Ltd.

It is interesting to note that the Queensland Government has been the only competitor to the companies mentioned here to manufacture a cement material in Queensland. This was in part due to the high rail freight component in the delivered price of cement at the site of one of its major projects. "At Koombooloomba a naturally occurring pozzolanic material has been successfully used as a partial replacement of cement in building the main dam, in the construction of which approximately 160,000 cubic yards of concrete were placed. This represents the first large scale use of a natural pozzolan in Australia, and the plant installed to process the raw material is understood to be the first pozzolan manufacturing plant in the Southern Hemisphere. Replacement of up to 30 per cent of the cement was found to be possible. The cost per ton of the processed pozzolan was about £10 per ton less than the cost per ton of cement at the site, so that in addition to the beneficial effects upon the resulting concrete, a substantial saving in cost was achieved."[14]

This production however was for a closed market. A more serious threat of competition came from imported Japanese cement in 1960. Three hundred tons were imported into Cairns and were offered for sale at a price substantially below that at which Stuart cement was available. A tariff Board inquiry subsequently found that the cement had been "dumped" in Queensland as the freight rate for the cement was only one-quarter of that which would normally apply. A tariff was imposed to effectively counter

---

[14] J.E.Kindler, "Engineering Structures in Queensland, 1951-60" in Introducing Queensland, Australian and New Zealand Association for the Advancement of Science, Brisbane, 1961

the threat to the local industry.[15] The State Government took further action by reducing by one-third the straight through freight rate on cement from Townsville to Cairns, to Mt. Isa and to Mackay.[16] (See Fig.17)

As stated earlier (and see Appendix 3) the North Australian Cement Company made use of the fact that its fuel was Queensland coal when seeking government assistance. In 1965 however the company changed to the use of oil fuel and so effected significant savings on fuel costs.

In each of the three financial years up to the end of June 1966, two-thirds of the cement produced at Stuart was consigned by rail to its destination. This is a far greater proportion than that for Darra and it reflects the smaller percentage of the regional population to be found in the city near the centre of the market. It also reflects the importance of development works being undertaken in many areas of North Queensland. (See Appendix 4).

5. ESTABLISHMENT OF THE PARKHURST PLANT, ROCKHAMPTON

In 1945-46 less than 4,000 tons of cement were sold in Rockhampton and its hinterland to the west, this quantity representing only 3.6% of the total sales in Queensland in that year. In 1961-62 the market in Rockhampton

---

[15] Tariff Board Report, 10th November, 1961, Department of Trade, Canberra.

[16] Report of the Director of Secondary Industries, Department of Labour and Industry, Brisbane, 1961.

and Gladstone and their hinterlands was only 4% of the Queensland market, and this then represented a quantity of almost 15,000 tons. Even this amount would not be sufficient to warrant the establishment of a cement works in which the cost structure of operations would incorporate such economies of scale as to make the works efficient by modern standards. However a plant has been constructed at Rockhampton and to understand the reason for this it is necessary to examine the circumstances under which it was established and under which it may operate. Without an understanding of the social and political pressures which led to its establishment, and the conditions of collusion under which it will operate, the location of a plant in the area at all is not intelligible, as it is certainly not at this stage economically justifiable. In this examination a knowledge of developments at Stuart can offer valuable aids to understanding, as there are many interesting parallels between the two cases.

In the late 1950's considerable interest was aroused in the prospects for development of the Fitzroy Basin and the Rockhampton and District Development Association was formed. This association actively engaged in publicising the resources and possibilities of the region, endeavouring to attract industry and seeking governmental aid for development. Much of the Association's information on the resources of the region was based on that compiled for a thesis by M. Juppenlatz, Department of Architecture, University of Queensland. In September 1957 the local press published three articles based on the Juppenlatz thesis which mentioned amongst many other things that "pure limestone, the basis of the cement industry, is available in large quantities".[17] It is not claimed that this statement prompted local agitation for a cement works but it is the earliest reference to the possibility of cement production in the area which has been located. More influential would have been a brochure compiled by Glenister Shiel, Resident Director and General Manager of Mt. Morgan Limited. In this brochure it is stated that "In the Capricornia area huge deposits of high quality limestone are known to exist. More than 100,000,000 tons are estimated to be in the Caves area while other large deposits occur at Marmor, Ambrose and Struck Oil."[18] Mr. Shiel considered other development prospects and went on to propose the construction of dams and irrigation projects in the Fitzroy Basin. He states that "These structures would call for sufficient cement to give the cement manufacturing industry a start-up load, just like the cement works at Townsville got, and would ensure a continuing base load, just like the Mt. Isa railway project will ensure for Townsville."[19]

Prompted no doubt by the local interest in such a project, in late 1959 the two existing Queensland cement companies together formed a wholly owned subsidiary, Central Queensland Cement Pty. Ltd., to operate in the Rockhampton area. This company had an initial capital of £85,000, three-quarters of which was provided by Queensland Cement and Lime Company. The new company acquired some World War II Army buildings beside the railway line at Parkhurst, 8 miles north of Rockhampton,

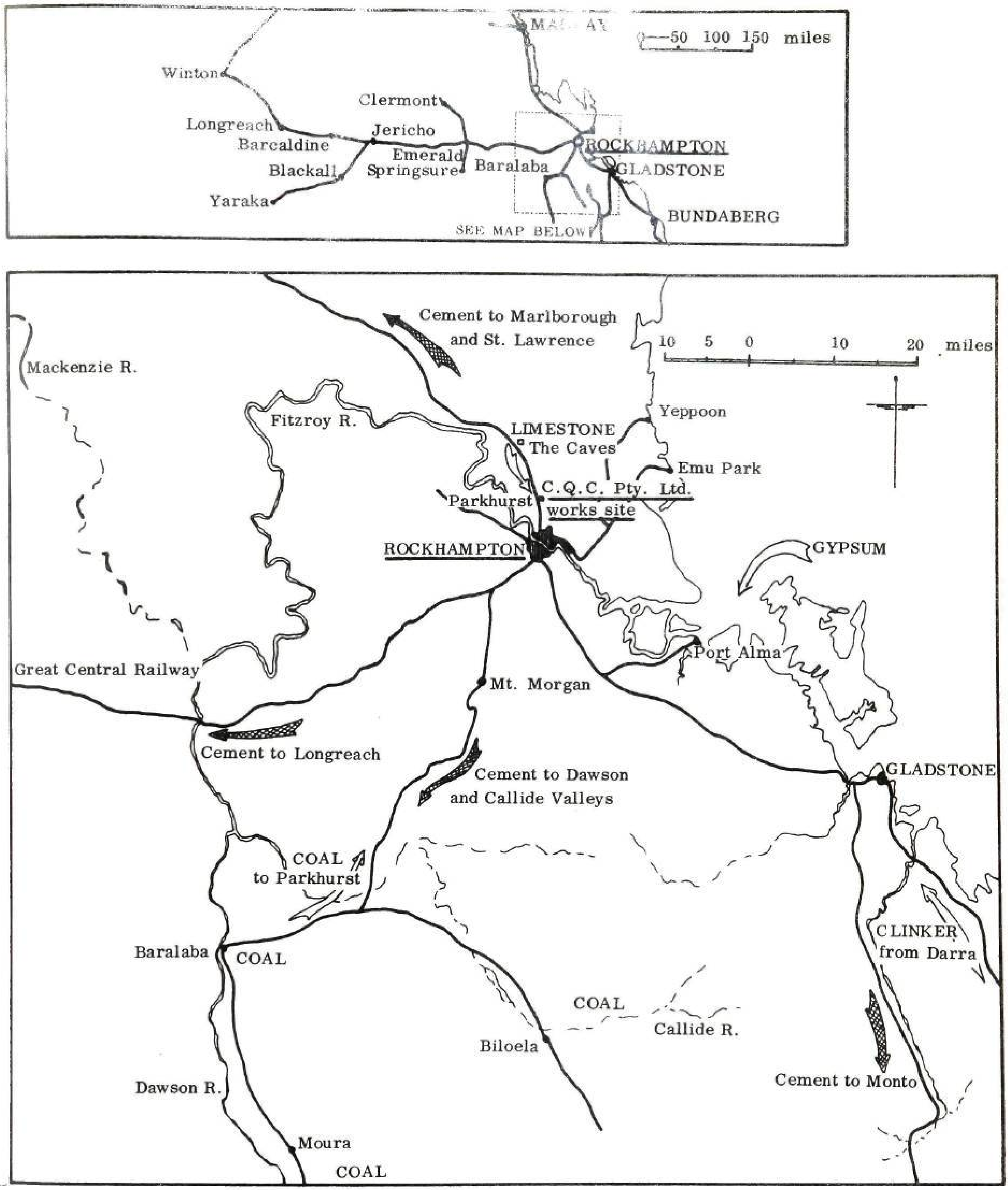
---

[17] "Potential of the Fitzroy River Basin", Morning Bulletin, Rockhampton, September 3, 4 and 5, 1957.

[18] G. Shiel, Chemical Industries in the Rockhampton Area, Rockhampton and District Development Association Rockhampton, p.4.

[19] ibid, p.7.

Fig. 15



LOCATION

The Parkhurst plant of Central Queensland Cement Pty. Ltd.; the market it is intended to serve and the main transport routes; sources and movements of raw materials.

and began operations in December 1959. At this stage this block of land was the only land that the company owned in the area and it was too small to be of use for a cement plant. The site was purely a marketing depot, was purchased as such and was located to minimize the costs of reaching the Central Queensland market.

When it was known in the area that the company was solely a marketing company and would merely sell cement from Darra from this depot, local agitation for a cement works began again. An attempt was made to form a local company but it was announced that Central Queensland Cement Pty. Ltd. would establish a clinker grinding and cement packaging plant to grind clinker from Darra to produce cement. The Report of the Director for Secondary Industries for the year ended 30th June, 1961 records: "Proposals for a similar industry have been submitted by a local company but it was not considered practical to financially support this second company to produce cement in Rockhampton when such a project was in process of establishment by an existing company".[20] The proposed local company had no doubt realized the inadequacy of the local market and had sought government assistance such as was provided for North Australian Cement Limited.

On the 30th June, 1961 tenders were called for the foundations of the proposed cement plant at Parkhurst

---

[20] Loc.cit., Department of Labour and Industry, Brisbane, 1961, p.7. This publication also contained the information that Central Queensland Cement Pty.Ltd. had sought and had been granted a guaranteed loan of £100,000 under the "Industries Assistance Acts". However the company did not require the loan and the offer lapsed.

and a year later the Director of Secondary Industry stated that "Production was anticipated to have commenced by the end of June (1962) but delay in construction work will probably hold up operations until October of this year."[21] It was April 1963 before the £200,000 plant began to operate.[22]

From a consideration of these facts in the light of what happened at the Stuart plant it would seem:

(1) That the parent companies realized that the Central Queensland market was growing towards a stage where a cement works could be supported, and therefore that a competitor could establish in the area;

(2) That the parent companies realized it would be many years before such a plant could be an economic proposition, but that initial steps had to be made to forestall competition;

(3) That a satisfactory delaying tactic would be to begin the construction of a plant erecting the final processing stages first and, when demand conditions warranted it, erecting the primary stages;

(4) That, despite the hopes of persons in the Rockhampton area, the plant will not be fully operational until it can work to its planned capacity.

This last supposition is one that will be capable of verification at some time in the future. If this prediction is correct it will in turn verify the preceding

---

[21] ibid, 1962, p.6.

[22] Developments in Australian Manufacturing Industries, Dept. of Trade, Canberra, 1963-64.

assumptions on which it is based. During the years 1961 to 1963 when the Parkhurst plant was being started, in view of the existing surplus capacity at Darra and Stuart, it seemed that it would be several years before this verification occurred.

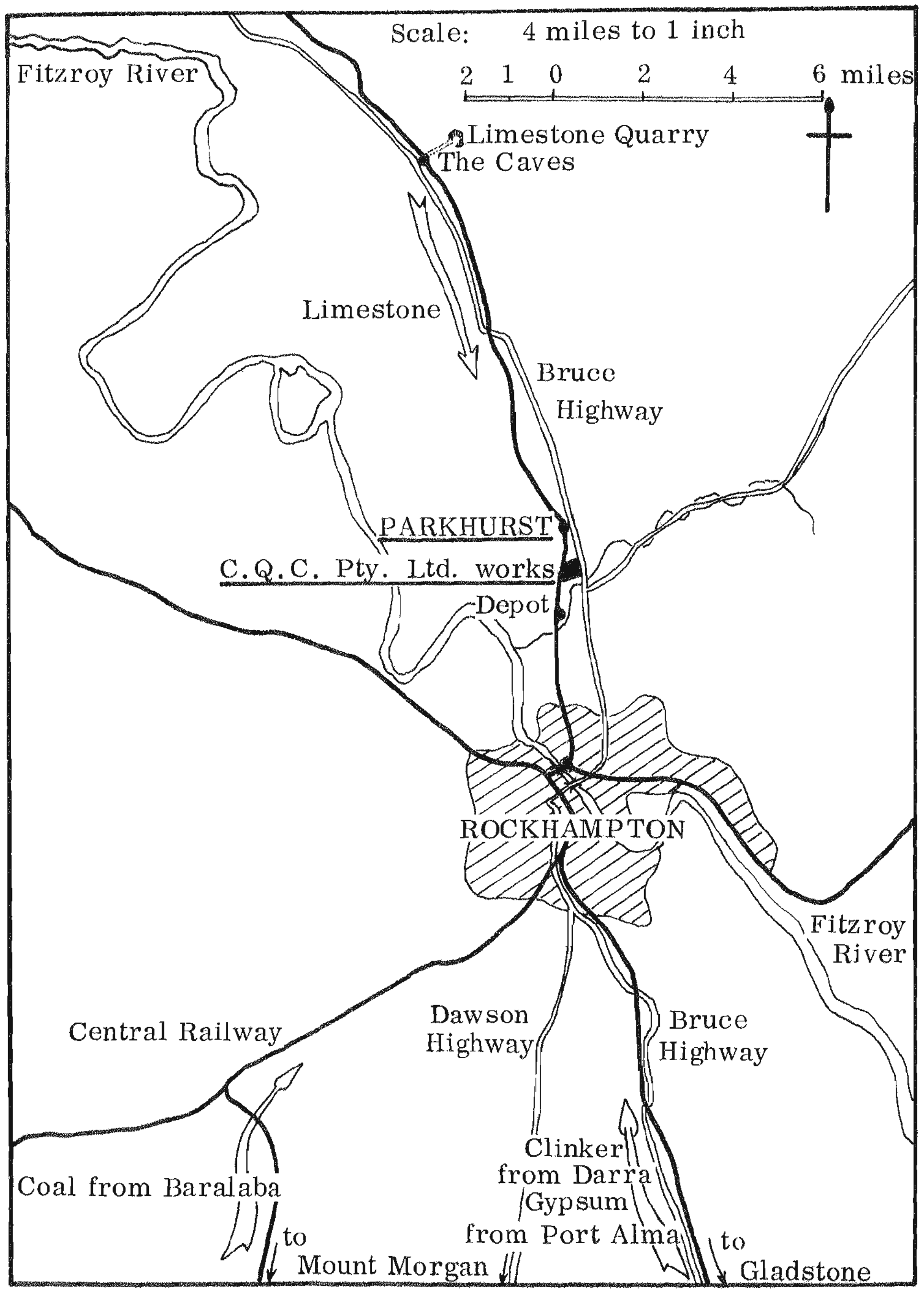
Three complicating factors must be considered; first, collusion between the parent companies, second, manipulation of freight rates by the Queensland Government and, third, commencement of development projects by the government.

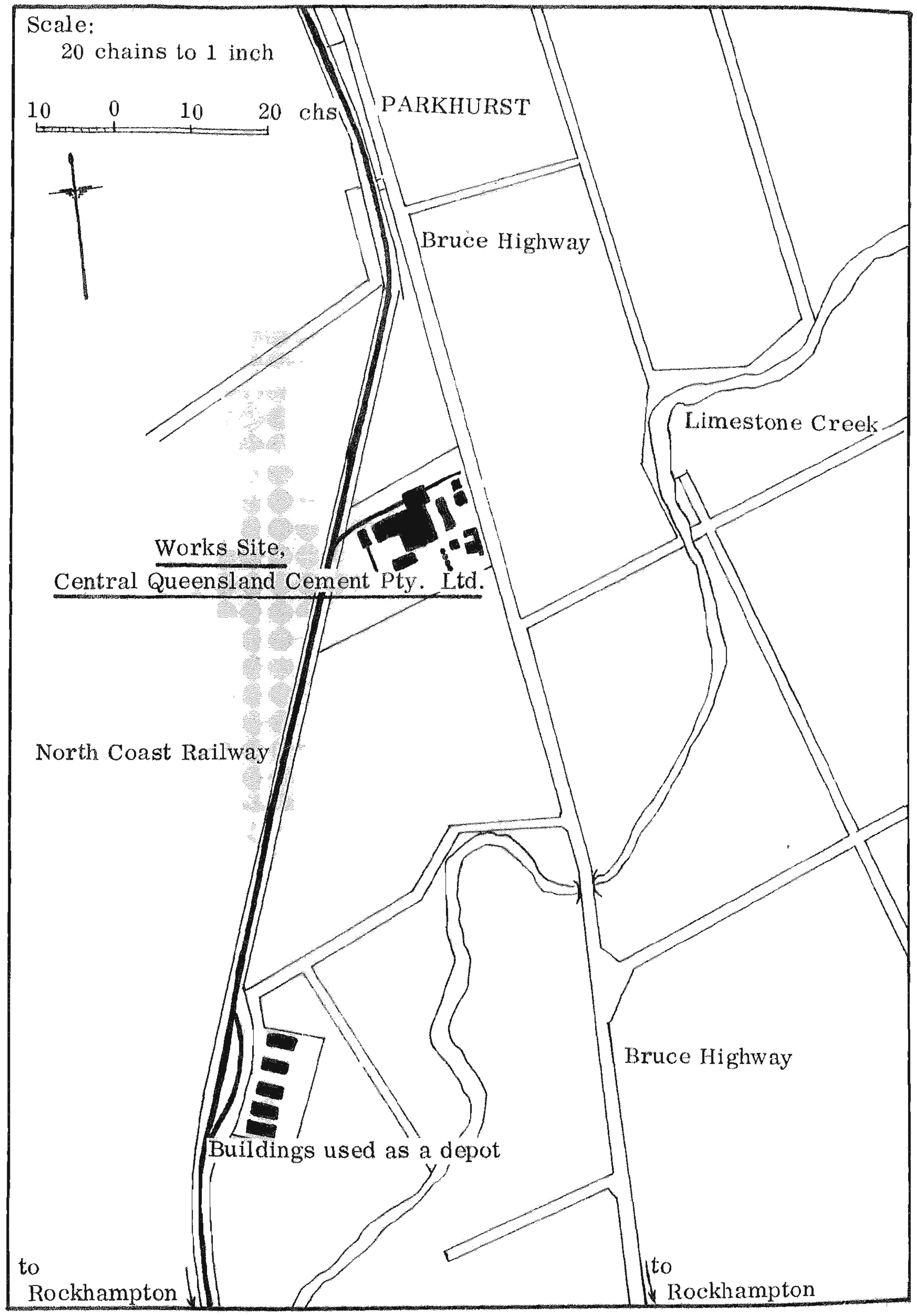
A plant in Rockhampton having a factory price equal to that at Darra and given similar freight rates could usurp markets as far south as Bundaberg. But it is most unlikely that a small scale plant could do so. If the Darra price of cement were raised, or if the government offered a straight-through rate to Maryborough from Rockhampton, then an extension of the market area of the Parkhurst plant would be possible. If the parent companies approached the points where they were each producing at close to capacity rates, they could decide on expansion at Parkhurst as an alternative method of making the increase in capacity necessary for the state as a whole. Such an action could be profitable if it avoided the simultaneous large increases in productive capacity that could have to be made. Each of the parent companies could continue to operate at its optimum near-peak level and the subsidiary could be used to gain certain tax benefits. If further increases in demand occurred the parent companies could apportion this to bring the affairs of the subsidiary to a satisfactory

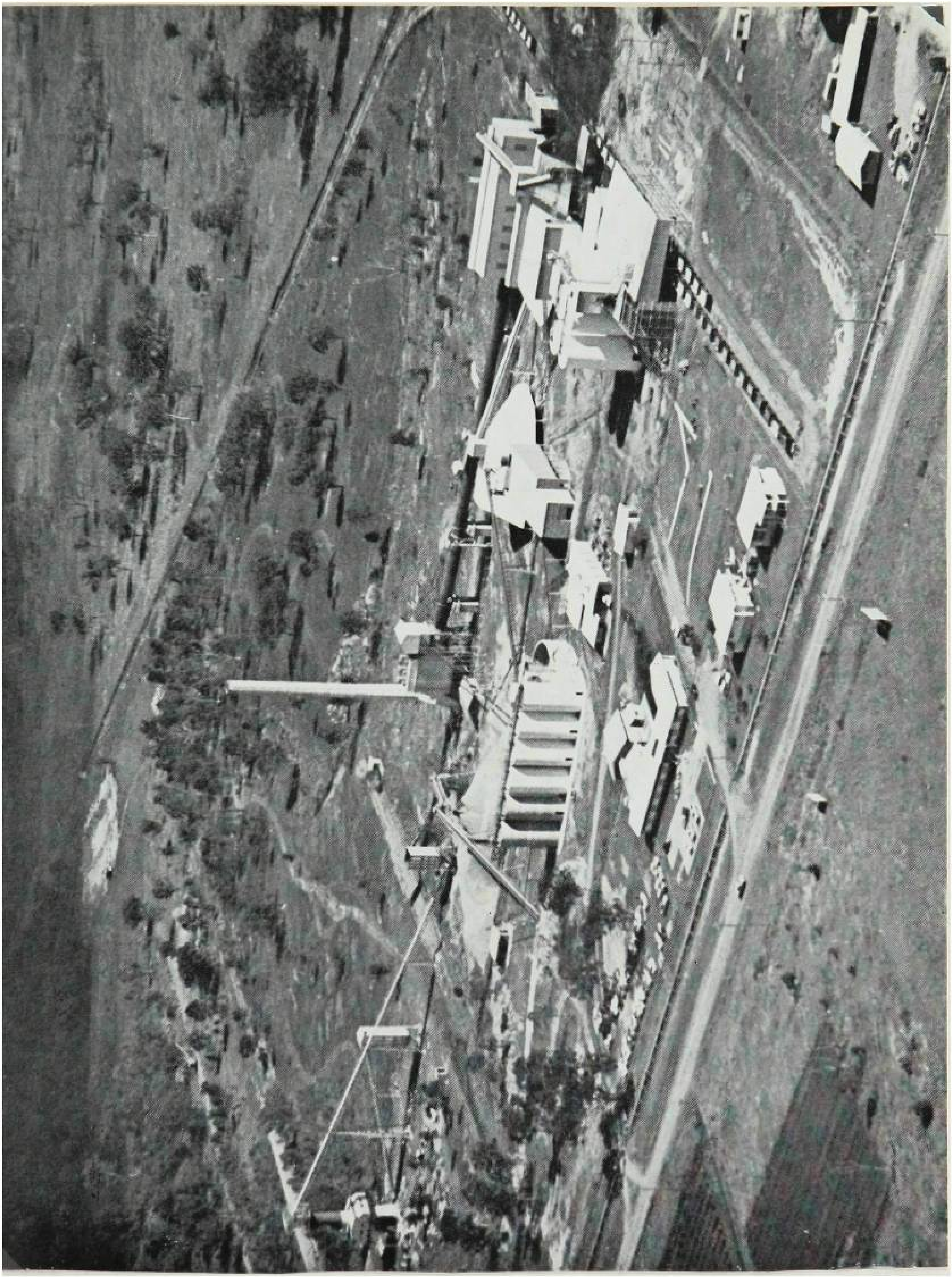
Fig. 16

SITE

The site of the Parkhurst plant of Central Queensland Cement Pty. Ltd., showing road and rail transport facilities, the direction of movement of materials and product and the utilization of the site by the company.







CENTRAL QUEENSLAND CEMENT PTY. LTD.
Aerial view of Works at Rockhampton

level. If the government revoked the special Townsville-Mackay rate and introduced a special Rockhampton-Mackay rate, this also could extend the market area of the new plant. Such actions could more than double the demand it would be called on to satisfy and would allow it to begin full operations. Finally, if the government began some project[23] which would ensure additional demand, the same purpose would be served.

However it does not seem that any event will occur which will contradict the first proposition of the thesis being argued here: a plant will be established in a region only when it is warranted by the growth of local demand.

The market which the new plant has been built to serve was, in 1960-61, still very small. All of the cement used in the region was supplied from Darra by rail. From Railway Department figures it is possible to obtain a fairly clear picture of the distribution of demand.

---

[23] Such as the Nathan Gorge Dam on the Dawson River or the Maraboon Dam on the Nogoa River.

TABLE II

Cement Consumption in Central Queensland, 1960-61

A	Consignments from Darra:	
	to Gladstone	252 tons
	to Central Queensland Cement Coy.	11,481 tons
	Regional Total	11,733 tons
B	Consignments from Central Queensland Cement Coy:	
	to Gladstone	224 tons
	to centres on Great Western Railway	2,948 tons
	to centres in Dawson & Callide Valleys	958 tons
	Total consigned by rail	4,310 tons
	Remainder of regional total, apparently consigned by road to in and around Rockhampton	7,351 tons

Thus the total consumption of cement in the region was less than 12,000 tons, more than half of this was used in and around Rockhampton. Another one-quarter was railed along the western railway line to various centres and one-tenth was used in the Dawson and Callide Valleys. Gladstone was supplied both from the Parkhurst depot and from Darra directly.

The pattern of demand distribution would not be expected to alter greatly but there were in 1960 already hopes for extra, if temporary, markets in projected developments at Gladstone and in the Callide Valley. Such existing patterns, and projected future patterns, of demand distribution would have made it obvious that a near Rockhampton situation was the most satisfactory for serving the market, a conclusion that had apparently been reached years before when the marketing depot was opened.

There are many good quality limestones suitable for cement production to be found quite close to the market centre. The limestone deposits which have been chosen by the company are at the Caves, 17 miles north of Rockhampton. Coal could be obtained from several fields but the most likely source is Baralaba which would involve a rail haulage of about 90 miles to Rockhampton. Because of the need to be close to Rockhampton for reasons of marketing and labour availability, and because of the locational pull of the limestone, a general situation was sought on the northern outskirts of Rockhampton close to the railway. This takes in the general area of the marketing depot. For the site of the actual plant the company was able to buy a suitable area of ground about half a mile north of the depot and a spur line was built onto the site. The land acquired had the necessary clay deposits and lay between the main North Coast line and the Bruce Highway (the main northern road). The site is only 9 miles from the Caves where the limestone deposits are, and so is in easy access by either road or rail. Unless the State Government makes special concessions on freight rates -- either on the limestone, or on coal or cement -- it seems certain that only road transport will be used. The use of rail transport for the limestone would be practicable only if a spur line were built into the quarry area to minimize handling costs. The site has direct access to power supplies and the Rockhampton water supply. Water is not available at the site and even at present is a problem as purchase from the Rockhampton

Council is expensive, though it may be cheaper when the water is available from the new barrage on the Fitzroy River from which it may even be available directly. The barrage, a mass concrete structure less than a mile upstream from the centre of Rockhampton, was begun in November 1966 and is due for completion late in 1968.

In 1963 the company began crushing clinker railed from Darra and continued operating in this way until mid-1966. For the next six months Stuart clinker was used but in November 1966 the expanded plant began making cement from its own limestone and "the parent company ceded a portion of sales territory to the subsidiary".[24]

---

[24] Annual Report of the Queensland Cement and Lime Coy.Ltd. for the year ending 31st July 1967.

CHAPTER VIII

THE TRANSPORT OF CEMENT.

1. RAIL TRANSFER OF CEMENT.

The fact that in the final analysis it is transfer costs which give form to the locational patterns observable in an economy is argued in several places throughout this study. In the case of the cement industry in Queensland the railways have provided the required low-cost bulk transfer system. An investigation of the movement of cement by rail is therefore an essential part of this study for four main sets of reasons. The first is the importance in general terms of this mode of transport to the industry; the second is the importance in the location decision of both the existing pattern of lines and the freight rate structures; the third is the fact that the statistics available in the rail transfer of cement can provide the only detailed description of the transport of the product to market; and the fourth is that an investigation of this main method of long haul transport can provide information about the nature of the separate regional markets of the state. For these reasons an investigation was made into the transfer of cement by rail in Queensland for the final years of the period covered in this location study.

Primarily the investigation was concerned with the use of rail transport to serve some part of Queensland cement market, the location and nature of the part of the market served by rail and the relative importance of this form of transport. It was also possible to investigate the nature and extent of separation between the regional markets, a problem that is of interest intrinsically and for its relationship to the wider problem of market boundary definition. It was also possible to investigate certain short term changes over the period under investigation. As it will be possible to present only a brief outline of the main points brought out by this study, attention will be directed to the following:

(a) the importance of rail transport to the cement industry with special reference to locational implications;

(b) the relative importance of this method of transport and the information that can be deduced about the transport of cement in general;

(c) the importance of the carriage of cement to the railways which helps to explain the strong bargaining power of the Queensland cement companies with the Queensland Government.

The period under investigation in the study was from the first of July 1963 to the thirtieth of June 1966, a period of three financial years but such data as could be gathered concerning the overall picture for earlier years were also collected. The main sources of data were the records of the Statistical Branch of the Queensland Government Railways. From the records it was possible to extract information relating to consignments of goods from selected stations to other parts of the State. The records were used to provide information for the three stations which are adjacent to the three cement works of the State. From these records the tonnages consigned to all other stations could be found. It was assumed that the supply of cement to distant parts of the State would originate at these, and only these, stations.

It is possible that interstate or overseas sources could supply markets in the State by means other than rail or by consigning goods from a station other than the three investigated. It is known however that overseas imports of cement are not the common grey portland cement produced in Queensland, but that these imports are of white and other coloured special masonry cements, aluminous cement and other special types. The total amount imported is small and, as these cements are not competitive with the local product, they may be ignored in this study. The situation with regard to interstate supplies is not so clear. It has been suggested that some cement enters Queensland from other States by road because of the special privileged position interstate road transport holds and because of the economics of back-loading goods from the Southern cities on trucks engaged in hauling Queensland's rural produce to Southern markets. Another method of supply is made possible by the system of distribution through agents who handle wholesale and retail sales. It is possible that cement could be sold to an agent and then later consigned through some station other than the three investigated.

Thus there are three ways in which cement could be supplied to outlying areas of the State other than by consignment through one of these three stations. It will be shown later that there is very little likelihood that any of these possibilities is of any significance.

In a previous chapter the discussion of the establishment of the first cement plant at Darra made obvious the importance of rail transport facilities in the original location decision. When, after thirty years of successful operation, the Queensland Cement and Lime Company set out to establish new plants in the other regional markets of the State, the location decision was influenced by the existing rail pattern in two ways. First, the general situation of each plant was chosen close to the centre of the market as defined by the rail lines which are its axes and the large city at the junction of these lines which is the main focus of demand. Second, the exact site of each plant was chosen immediately adjacent to the railway line so that a spur line could run into the works itself.

One of the most obvious features in the distribution patterns connected with cement production, consumption or transfer in Queensland is the difference in magnitude from one region to another. This difference can be noticed in the figures for regional distribution of cement sales as shown in Table 3 in Chapter IV. The regularity of this size difference over a number of years in these and other Queensland cement statistics prompted an investigation of some simple correlations. It was found that, at the broad regional level there is a very high correlation between population distribution and the distribution of cement consumption: a positive correlation of 0.94 significant at the .001 level.[1]

This calculation verifies the assumption that can be made at the intuitive level that there is a relationship between population distribution and the distribution of cement consumption. What is surprising in the result is the fact that the correlation was so high considering the fact that cement consumption per capita in the central region is only one half of that in the South.[2] To explain this discrepancy some consideration must be given to

---

[1] The calculations were based on the figures from Table 3 and the corresponding population percentages calculated from Queensland Year Books, using the form,

$$r^2 = \frac{(N\Sigma xy - x.\Sigma y)^2}{(N\Sigma x^2 - (\Sigma x)^2)\ (N\Sigma y^2 - (\Sigma y)^2)}$$

for 15 pairs of numbers (5 years, 3 regions)

$$r = 0.94$$

Testing for significance,

degrees of freedom = 13, $p = .001$

[2] It is realized also that correlation or regression co-efficients have rather high values when calculated for large areal units whereas when calculated for sub-regions within those units the values would invariably be lower. An impressive body of literature exists on the desirability of weighting, or of using some other technique such as spectral analysis for measuring spatial association. However it is maintained that, for the purpose to which the analysis here are put, direct unweighted values are satisfactory.

those factors which concentrate demand in metropolitan areas.

The next question prompted by this high correlation result is whether the correlation that exists at the broad regional level is the result of a correlation in detail between these distributions over a large number of small regions. It was found that this correspondence in detail does not exist. Instead, as will be shown later, very strong, temporary and local increases in demand are created by capital works programmes at various governmental and semi-governmental levels. These temporary local demands can dominate whole regional patterns. It only remains to ask then, at the level of what size of region can we make use of the assumption of a correlation between population and cement consumption; or alternatively, under what conditions can the assumption of correlation reasonably be made. To answer this question it was necessary to investigate the regions in more detail.

Comparison for each plant of the total production of cement and the amount consigned by rail makes it obvious that the relative importance of rail transport varies from plant to plant and also varies from year to year as different markets are served. During the three years investigated the percentage of the Queensland Cement and Lime Company's production consigned through Darra station varied from 22% to 19% to 20%. Each year approximately one-quarter of the consignments were to Brisbane so that in the three years 17%, 13% and 15% of the total production was railed out of the metropolitan area. If we allow for the amount consigned to Central Queensland we find that ten to fifteen per cent of Darra's production was railed to destinations in South Queensland outside of the metropolitan area. During this time the percentage of the population in the southern statistical area of Queensland living outside the metropolitan region and the Moreton region was 21%.

When the figures for central Queensland are examined it is found that only from 30% to 45% of the production at Parkhurst is railed away. However when the amount supplied to Central Queensland from Darra is included we can calculate the consumption outside of Rockhampton as a percentage of the total consumption in the region. In 1963-64, 60% of the cement used in Central Queensland was used outside of Rockhampton, in 1964-65 the figure was 62% and the following year 71%. During this period 70% of the population of the Central statistical area of Queensland lived outside of the city of Rockhampton and the adjacent shire areas.

The corresponding figures for the North Queensland cement consignments declined from 65% to 51% over the period while the population remained constant at 78% of the total for the region living outside of the Townsville area.

The overall correlation between percentages of population in each market area away from the main centre and the percentages of the total regional cement consumption which was consigned by rail is quite high.[3] That the correlation exists at this high level gives confidence in the assumption that rail transport is the main means of supply for the areas outside the large centres adjacent to the cement works. It also makes unlikely the possibility that there are sources of cement outside the state supplying significant tonnages of cement to outlying areas. It also makes less likely the importance of indirect supply of outlying areas with reconsignments by agents through other stations than the three investigated. Finally, it allows a greater degree of reliance to be placed on the assumption that the rest of the cement produced in Queensland and not consigned by rail was transferred by road to markets <u>near</u> the cement works.

It is known that there are no significant overseas exports of cement but the amount sent into northern New South Wales by the Darra plant is not known. This amount could be estimated at about 35,000 tons. This is the size of the discrepancy between the amount of the sales claimed separately by the Queensland cement companies and the figures published for total cement sales <u>in Queensland</u>. The estimate can also be made from the known population of the northern New South Wales sales area and the average per capita cement consumption for Australia.

---

[3] $r = +0.96$, $p = .001$ for the nine pairs of percentages, three regions by three years. r calculated as in footnote 1.

This estimated amount would be equal to about one-tenth of the amount of cement sent by road to markets near the metropolitan area.

So far in this section attention has been directed to the importance of rail transport to the transfer of cement. It is interesting to note in passing the reciprocal relationship, the importance of the transfer of cement to the Queensland Railways. Estimates can be made on the basis of the tonnages handled or the revenues earned.

Over the three year period investigated a total of almost half a million tons of cement was carried by rail in Queensland attracting freight charges of about four and one-quarter million dollars. The table below shows the annual average cement consignments (for the three years) compared with the total for all "Minerals", and the total of all goods consigned in 1963-66.

TABLE 12.

Tonnages Carried & Revenues Earned for Cement and other goods.

Commodity Class	Weights	Revenues
Cement, annual average for period 1963-66	155,157 tons	$ 1,409,838
Minerals (including coal) 1963-66	3,306,000 tons	$ 7,208,000
Total, all Goods traffic 1963-66	8,153,000 tons	$30,177,000

From this it will be seen that cement constitutes only about 5% of the weight of all "minerals" and less than 2% of the total weight of goods consigned for the year. The earnings however from the transfer of cement are more than 20% of the earnings of the class "Minerals - (including coal)" and are 5% of the total freight revenue. Since the freight rate on cement is quite a low one (less than one half that for Merchandise Class 1 or one-quarter that for Merchandise Class 2), the reason for this high proportion of the revenue must lie in the length of haul of the cement.

The traffic associated with the transfer of cement in the period under investigation was about 25 million ton-miles. If the total amount of cement used in North and Central Queensland had originated at Darra instead of at the regional cement plants, then its distribution would involve an extra 100 million ton-miles of traffic. The additional freight which would have to be borne by the consumer would be of the order of two to two and one-half million dollars. This would be approximately $5 per ton if the cost were borne equally by all consumers in the state. If it were borne by consumers in the North and Centre solely then the increase would be of the order of $20 per ton. It is this outlay on freight that the establishment of regional cement plants seeks to avoid although it is realized that the smaller scale plants will have higher production costs.[4] In the economist's terms the decision to locate new cement plants in the Northern and Central regions instead of increasing capacity at Darra involved the substitution of higher production inputs and lower transport outlays in the small regional plants for the lower production inputs but higher transport outlays of a large scale plant at Darra. This is another aspect of the influence that the rail system has had on the location of cement production in Queensland.

2. DIVISION OF THE MARKET.

It has been shown earlier that, because of the uniformity of the product, there can be no real product discrimination between different producers except on the basis of delivered price. Where a true non-discriminatory plenary pricing system or an f.o.b. works price system is used, the market area can be divided fairly simply between the producers on the basis of their costs of production plus costs of transport. This is not exactly the case in Queensland. The Brisbane metropolitan area has a fixed price for all distributors regardless of distance from Darra, and the surrounding area served by road transport has prices based on either the "ex-works" price or the Brisbane price. A similar situation applies to the area around Townsville and the Stuart works.

---

[4] The relationship between distance, transport costs and cement prices is shown graphically and on maps in Section 2 of this Chapter.

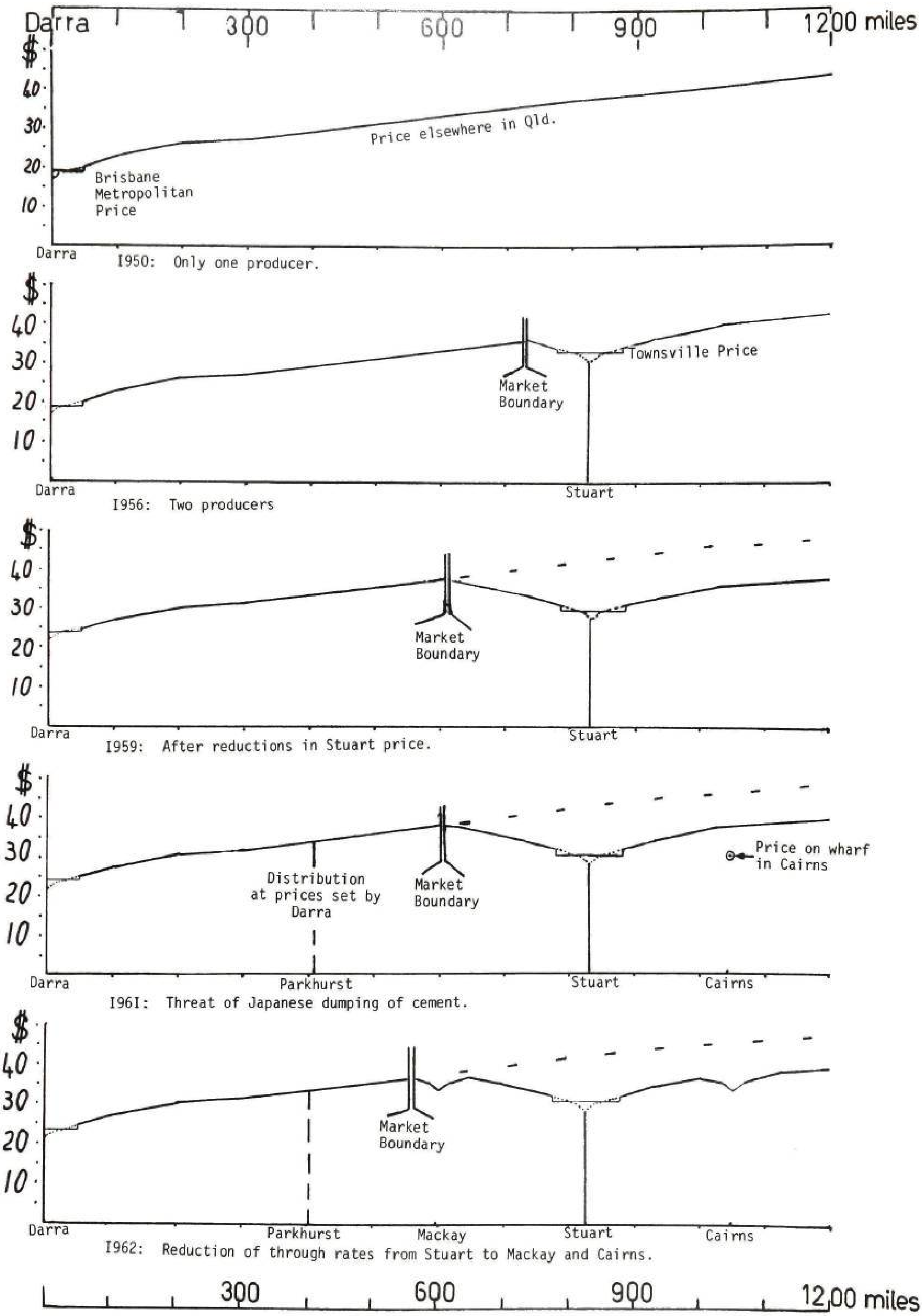
However most of the rest of the State does receive its cement on an f.o.b. works price basis.

A series of simple models can demonstrate the levels of prices at the cement works and at distances from the works for various years. The way in which the price changes and changes in freight structures have affected the market boundaries can also be shown.

The first model demonstrates the relationship between prices at varying distances from Darra and the Darra and Brisbane prices in 1953. It will be seen on this and subsequent models that the freight rate per mile in the first two hundred miles is approximately double the rate per mile in subsequent distances. The second model demonstrates the way in which the higher-cost producer at Stuart was able to usurp markets in its immediate area and, at distances beyond Stuart, to compete equally with the Darra producer. In fact at this period the Darra plant was unable to meet the full Queensland demand and so the Stuart plant had no real competition in this area.

After some years of successful operation the price of cement at Stuart was reduced and the third model shows how this assured Stuart's monopoly in the area around and beyond Townsville. The interval between the broken line and the full line represents the saving due to supply from Stuart rather than

Fig.17 Cement Prices and Distances from Cement Works.



Darra. The final models show extension southward of Stuart's market area following an increase in the price of cement from Darra and following the granting of a freight reduction of one-third on cement railed to Mackay or to Cairns from Stuart.

In these models the distribution of cement from Parkhurst is shown to have no effect on prices as the prices charged are simply those set for sale of cement from Darra. As a result no market division can be drawn.

It is not feasible on such models to try to show prices along the main branch lines that run inland from the coastal line. To show these the most useful method is portrayal on a price map for the State. An anomaly may then be seen at the Western end of the central railway. This is caused by the operation of a special "ex-works" price granted at Darra for consignments to stations from Alpha west to Longreach. This special price was granted to allow the company's distributors in the area to meet competition from cement being brought into the area from northern New South Wales. This cement was invariably "ACE" cement from Darra which was being brought from across the State border to avoid road tax. The company was not losing by this means of supplying the market and its action was taken to keep faith with its distributors in the area. This map also makes apparent the distances that cement can be transported from the works before

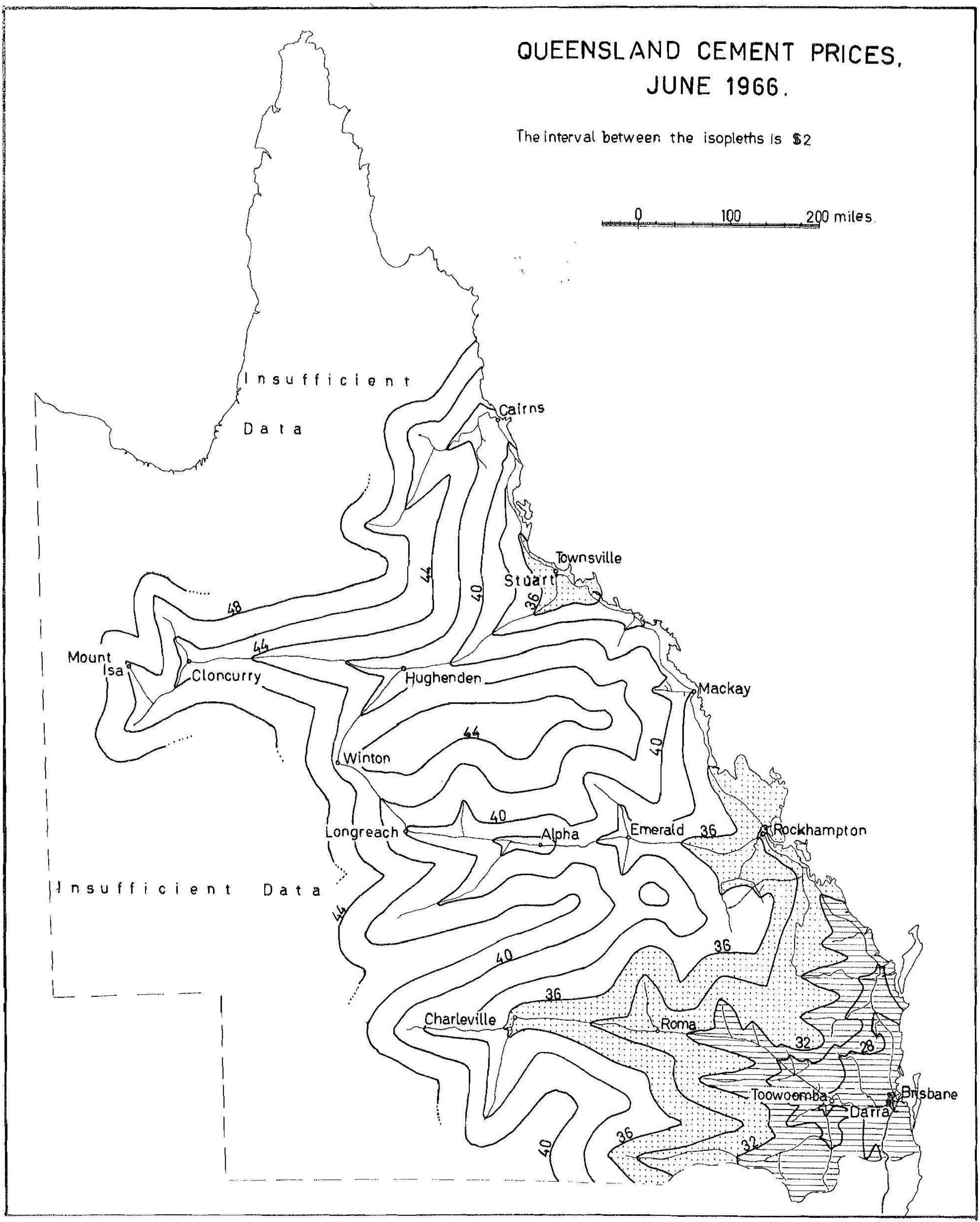
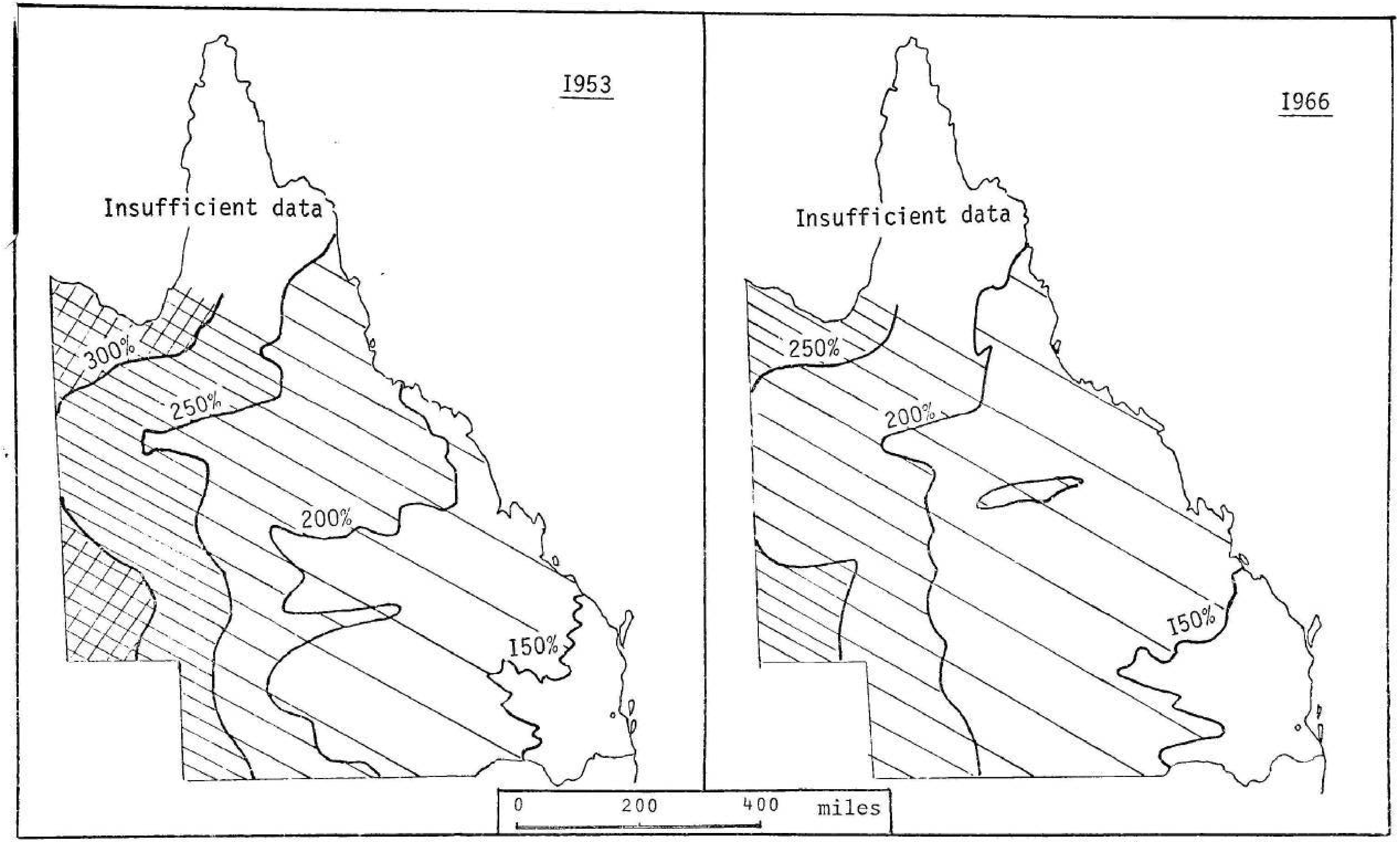

QUEENSLAND CEMENT PRICES,
JUNE 1966.
The interval between the isopleths is $2
0
100
200 miles.
Insufficient
Data
Cairns
Townsville
Stuart
Mount
Isa
Cloncurry
Hughenden
Mackay
Winton
Longreach
Alpha
Emerald
Rockhampton
Insufficient Data
Charleville
Roma
Toowoomba
Darra
Brisbane
48
44
40
36
32
28

Fig. 19

QUEENSLAND CEMENT PRICES, 1953 AND 1966



The prices are expressed as a percentage of the prevailing Darra price for cement. In 1953 the Darra plant was the only producer but in 1966 the Stuart plant was also fully operational.

reaching some given price level. It can be seen that Darra cement can be railed approximately five hundred miles and can be sold at about the same price as cement railed only fifty miles from Stuart. This shows on the one hand the economies resulting from large scale production at Darra and, on the other hand, the effects of distance and freight costs in shielding the smaller higher-cost producer at Stuart.

However there are advantages in supply from Stuart. As Fig.17 shows, the higher cost producer at Stuart can still provide cheaper cement in many areas. The nature of this saving to northern and north-western Queensland is shown in the two maps showing cement prices in 1953 and 1966. By showing the prices as a percentage of the prevailing Darra price, the effects of changes in real money values can be overcome. Whereas in 1953 two-thirds of Queensland had cement prices more than twice the level of the Darra price, in 1966 just under one-half of the State had to pay these higher prices. It must be remembered however that this half of the State used less than 5% of the cement.

In section 4 of Chapter IV, reference was made to some results of a study of the transport of cement by rail in Queensland. (See Appendix 4). Another important result of this study was the information it provided about the nature and extent of separation between the regional markets. Some of the major patterns that could be observed in the flows over the three years of the study were:-

(1) the almost complete separation of the areas supplied from each of the three plants;

(2) the contrasts between the three main parts of the pattern in size of flow, parallelling contrasts in size of plant, and in length of flow, reflecting different areal distribution of the market. First, it is noticeable that there is a large difference between the size of the flows from Darra or from Stuart when compared with those from Parkhurst. Over the period investigated the tonnage from Parkhurst increased but the consignments, even in the final year when they had almost trebled those of the first year, were still only about one-seventh of those from Darra. Second, it is apparent that there is a great difference in the concentration or dispersal of demand in each of the three regional markets. This is most obvious in the contract between the concentration in the South-eastern corner of the Southern region served from Darra and the dispersal over the northern region served from Stuart.

If the stable elements of the pattern are to be found in the inter-regional contrasts in magnitude and direction, then the most dynamic features are to be found in the intra-regional variations in these same aspects of the pattern.

The total amount of cement consigned from the three stations varied only slightly over the three years but the amount consigned from each station varied more considerably. There was a slight decline in consignments from Darra over the period, a rather more severe decline in consignments from Stuart but a large increase in the flow from Parkhurst.

If the flows from each station are examined it is possible to isolate certain stable and certain varying segments. These changes in the amounts consigned to different parts of each of the regional markets reflect shifting patterns of demand within these markets. It is fairly simple on a map to portray visually these varying patterns but it is very difficult to measure objectively the varying concentrations and dispersals evident on the maps. One parameter of concentration or dispersal is the mean haul distance or average length of haul. The mean haul distance was greater for the northern than for the other regions having an average value of 220 miles --- approximately the distance from Townsville to Mackay or to Cairns or to Hughenden. The lowest value for this parameter was for the southern region. The overall value was 115 miles, approximately one half of that for the northern region. The variation over the three years was small but significant. The value gradually increased from 105 to 120 to 125 miles, and this increase was due to the growing proportion of the cement and clinker being consigned to Central Queensland.

The central region had an intermediate value for the mean haul distance (145 miles) but it was the average of the three most widely varying values: 205 in the first year, 160 in the next and 120 in the last. This big decrease reflects the increasing importance of consignments to Gladstone as against consignments along the Western line.

Almost two-thirds of the cement railed each year originated at Darra. The station at Darra is used by industrial plants other than Queensland Cement and Lime Company, but this company is responsible for most of the rail traffic originating at Darra. The following table shows the consignments of cement and clinker and the relationship of these to the total of goods railed from the station during the period under investigation.

TABLE 13

Consignments from Darra

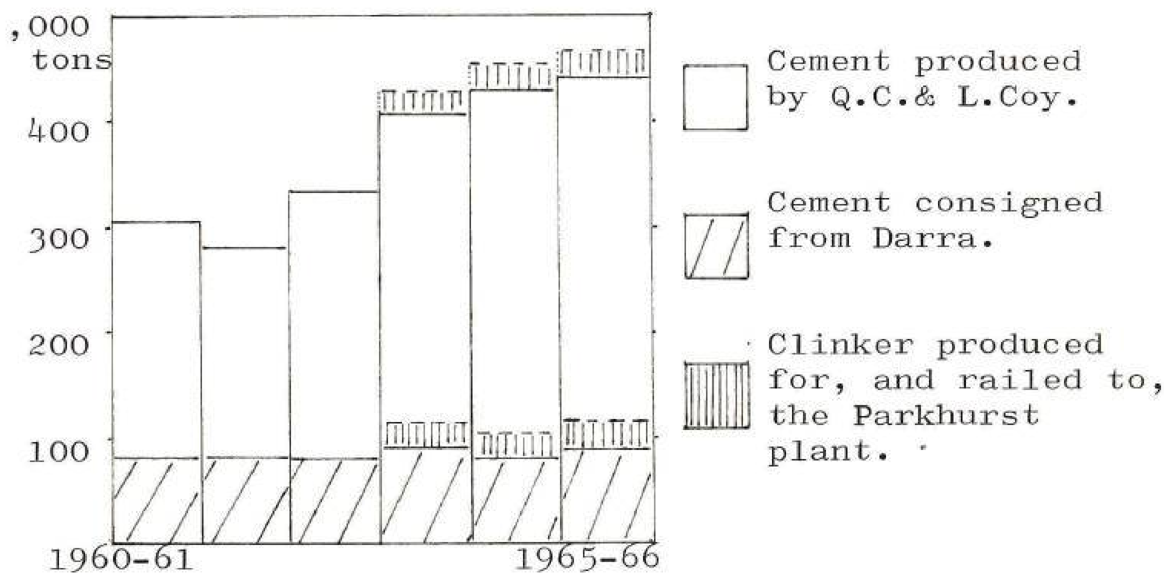
		1963-64	1964-65	1965-66
(a)	Cement (tons	91,734	80,938	87,372
(b)	Clinker to Parkhurst (tons)	16,787	20,382	23,337
(c)	Total, Q.C.& L.Coy(a+b) "	108,521	101,320	110,709
(d)	Class: Other Minerals "	112,027	104,953	114,066
(e)	TOTAL : ALL GOODS "	112,090	105,007	114,155
(f)	(c) as % of (e)	97%	97%	97%

From this it will be seen that the errors involved in considering consignments from Darra as consignments of cement or clinker are very small.

During the past six years rail consignments of cement have not increased at the same rate as that of the total production of cement at Darra. As the following graph shows the rail consignments of cement have remained rather stable over this period and therefore represent a declining percentage of production. If, however, the consignments of clinker to Parkhurst are recognized as a new way of supplying the Central Queensland market, then the clinker railed to Parkhurst should be added to the cement consignments. This same tonnage which can be regarded as clinker produced on behalf of Central Queensland Cement Pty. Ltd., should then also be added to give the total production at Darra. The broken lines indicate the augmented production and consignment quantities and show that the proportion of production consigned by rail has declined only very slightly over the period.

FIG. 20.

Production at Darra and consignments by rail



Only two customers in Brisbane were served by rail, Wunderlich Ltd. and Hardie & Co. Pty. Ltd., manufacturers of asbestos cement goods. This was one of the most stable parts of the flow patterns but the largest flow was through Brisbane along the North Coast line. Roughly one-sixth was consigned to places south of Gladstone in what is usually regarded as the Queensland Cement and Lime Company's market area. The largest rail consignments of all went to Central Queensland: 27% of total consignments in 1963-64 to 43% in 1965-66. There was in this period a substantial increase in shipments of clinker to Parkhurst. However the main element in the increase was the enormous growth in the amount of cement railed to Gladstone for the construction of the alumina plant and associated works. This huge increase more than compensated for the decline in supplies from Darra to the Callide coalfield over the period. This cement had been for the construction of the Calcap power station and dam. The stations to which the cement was consigned were Callide, Biloela and Callide Coalfield. The first two are eight miles apart and the third is on an eight mile branch line from midway between them. The scale of the study has made it necessary to combine the figures being as for one regional market.

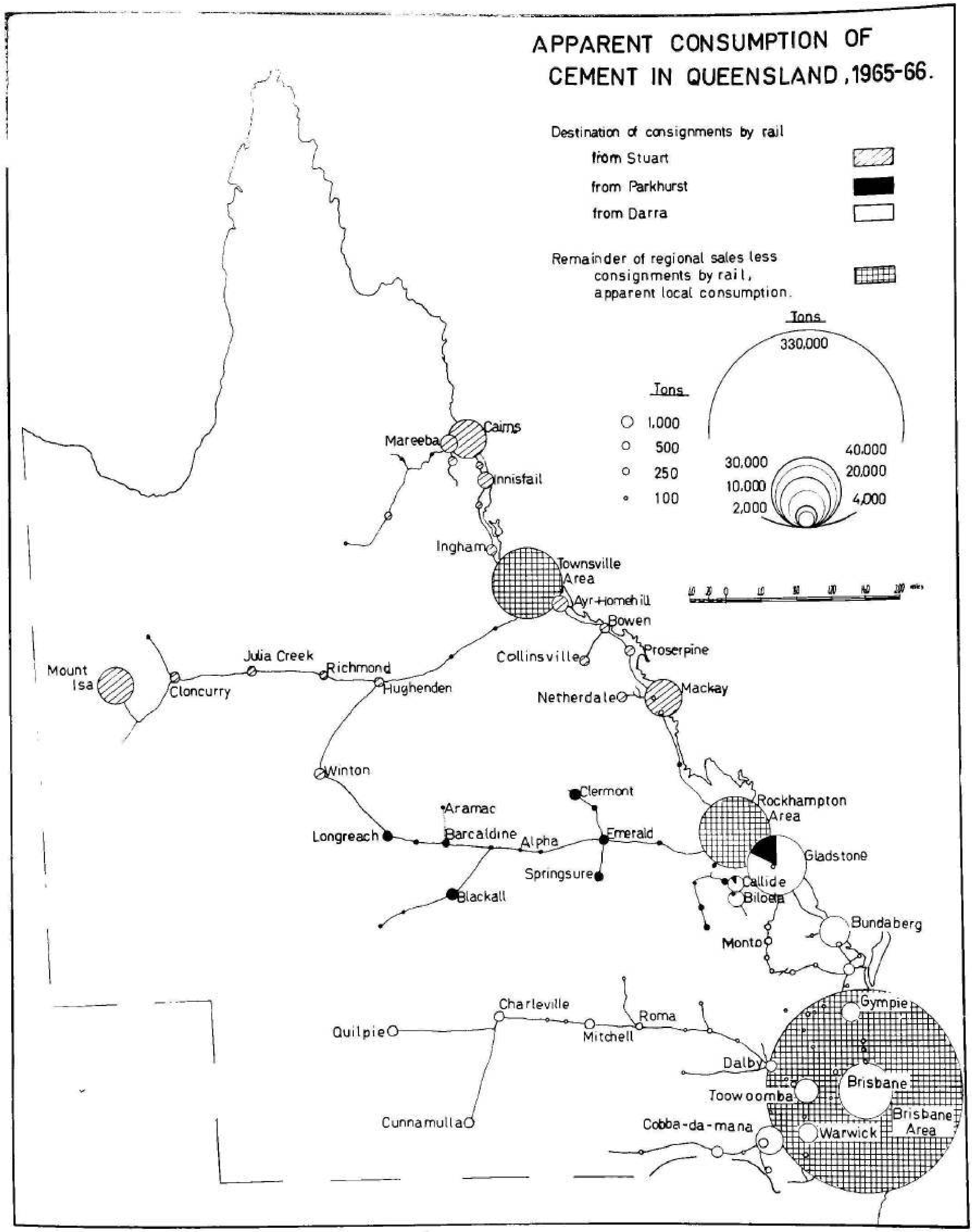
As has been stressed throughout this study, cement marketing in Queensland is characterized by the absence of competition, a fact that is related to the inter-related company structure and the geographical separation of the portions of the total Queensland market. However in the area along the main North Coast line near Gladstone and in the Dawson and Callide Valleys there has been something like competition for markets. It must be remembered however that the Central Queensland Cement Company is wholly owned by the other two companies and that the cement it was producing in the years under investigation was made from clinker from Darra and, at the end of 1965-66, from Stuart. Thus whether Darra supplies a market in Gladstone direct or whether clinker is railed to Parkhurst and the resulting cement supplied to Gladstone is a case which involves no real competition.

Nor is there any real competition in the supply of clinker from Stuart instead of from Darra. In the Directors' report for the Queensland Cement and Lime Coy. 1966, it was stated that "sales of clinker have now ceased and the subsidiary company's requirements for clinker are now being drawn, by mutual arrangement, from North Australian Cement Ltd." In the Chairman's Address for the same year, it was stated that the Stuart clinker was priced more highly than that from Darra and that its purchase had "materially affected the profit" of the subsidiary company.

The complicated pattern of supply to this area near and inland from Gladstone could be seen as a conflict for markets between the two supplying companies. However it is more useful to see it as a stage in the planned course of geographic diversification of production decided upon by the Directors of the Queensland Cement and Lime Company. The first stage of diversification was the setting up of a plant at Stuart to supply the northern market. The next stage has been the establishment of the Parkhurst plant. It is therefore a matter of convenience that four-fifths of the cement used in Gladstone in 1965-66 came from Darra and one-fifth from Parkhurst. No conclusions can be drawn from such figures concerning the relative abilities of the two plants to compete for markets.

The plant at Parkhurst is being developed to supply the Central Queensland market and its seeming competition with Darra for markets should continue in the form demonstrated over these three years. Firstly, as production at Parkhurst increases, its share of the relatively stable part of the market should increase until it takes over completely. An example in the period studied is the taking over from Darra of the supply to Moura. Secondly, when very large temporary demands are created in the region, cement is more likely to be supplied by the larger scale lower cost excess capacity existing at Darra, or Stuart. The shared supply of the Gladstone market over the period under review is best seen in this light.

However, as the Darra and Stuart works move closer to production to capacity, the desirability of having this excess capacity already established in the market area becomes more obvious. While the older works are producing to capacity and until their own expansion plans are completed, the Parkhurst plant may be regarded as shared excess capacity.


APPARENT CONSUMPTION OF CEMENT IN QUEENSLAND, 1965-66.
Destination of consignments by rail
from Stuart
from Parkhurst
from Darra
Remainder of regional sales less consignments by rail, apparent local consumption.
Tons
330,000
30,000
10,000
2,000
40,000
20,000
4,000
Tons
1,000
500
250
100
Cairns
Mareeba
Innisfail
Ingham
Townsville Area
Ayr-Homehill
Bowen
Proserpine
Collinsville
Netherdale
Mackay
Mount Isa
Cloncurry
Julia Creek
Richmond
Hughenden
Winton
Clermont
Aramac
Longreach
Barcaldine
Alpha
Emerald
Springsure
Blackall
Rockhampton Area
Gladstone
Callide
Biloela
Bundaberg
Monto
Gympie
Charleville
Roma
Quilpie
Mitchell
Dalby
Brisbane
Toowoomba
Brisbane Area
Warwick
Cobba-da-mana
Cunnamulla

It is now possible to form a fairly clear picture of the division of the market. From the information gained from the rail transfer study it is possible to plot the stations of destination for all consignments by rail from Stuart, Parkhurst and Darra. It has been argued earlier that the railway is the only important means of supplying the market in areas more than about sixty miles from the works. If this is so then the destination of consignment maps in Appendix 4 can be regarded as apparent consumption maps for the centres at some distance from the cement plants. Further, the apparent consumption in the region close to the cement plant can be calculated by subtracting the amount railed from the total regional sales. As was shown in the previous section, there is a high correlation between the distribution of cement consumption calculated in this way and the distribution of population over the State.

The apparent cement consumption map drawn in this way makes obvious certain facts that have been stated repeatedly in this study. The Queensland market has three main segments, each of which is based on one of the main western railway lines and each of which is centred on the large city at the junction of the western and coastal lines. Each of these markets is now served by a plant located at the main focus of demand and competition between the producers is negligible.

CHAPTER IX

SUMMARY AND CONCLUSIONS

1. THE PRESENT SITUATION: THE PRODUCERS AND THE MARKET THEY SERVE

Today there are three companies producing portland cement in Queensland. The oldest established and largest of these is the Queensland Cement and Lime Co. Ltd. with works at Darra that have a capacity of 500,000 tons and a production in 1966-67 of almost 440,000 tons[1] This plant, because of a factor which was purely fortuitous in the original location decision, has an extremely favourable cost structure and this makes its factory price for cement the lowest in the state. It provides at present the three-quarters of the total Queensland supply of cement that is required by the south Queensland market.

The second of the companies is North Australian Cement Ltd., in which the previous company has a 20 per cent interest and representation on the board of directors. This company has a works at Stuart with an

---

[1] In the past three years the Queensland Cement & Lime Co. has burned 437,839, 458,707 & 468,117 tons of clinker and has sold 433,084, 476,163 & 418,203 tons of cement. The lower sales in 1966-67 were the result of lower rates of construction caused by seasonal conditions but a good stockpile of cement and clinker was built up. These statistics are quoted because they show better than the cement production figure given above the closeness of production to rated capacity.

annual capacity of 120,000 tons and a production in 1966-67 of over 110,000 tons.[2] The cost structure of this company is less favourable due to its smaller scale of production. In the past another factor was the costly fuel which it used in return for favourable government consideration in respect of tariff protection and freight rates for cement, and for the government-financed purchasing which allowed it to operate at an economic level. This company serves a very extensive market area although three-quarters of its sales are made within fifty miles of the railway within three hundred miles north or south of the plant.

The third company, Central Queensland Cement Pty. Ltd, is a wholly owned subsidiary of the Queensland Cement and Lime Company and North Australian Cement Limited. As has been argued here its establishment seems to have been prompted by the need to forestall competition in the vulnerable third regional market midway between the other two producers where their delivered price for cement is highest. But as this regional market was too small to support a full cement plant, the later stages of the plant were constructed first to grind clinker from Darra or Stuart. Local demand was increased by the undertaking of large development works by the Queensland Government and by private enterprise, particularly mining companies. The primary stages of the plant

---

[2]In the past three years North Australian Cement Ltd. has sold 102,777, 90,240 & 104,764 tons of cement; as well in 1966-67 9,515 tons of clinker were sold. Again the nearness to capacity should be noted.

were built when the additional capacity was needed to cater for this increased local demand, but another important consideration was the fact that both of the older plants were already working to capacity.

The outstanding feature of the market served by these companies is the lack of competition. The areal extent of the market and the over-riding consideration of market orientation in the industry have forced a degree of geographical diversification on the industry. However the company structures have allowed, or encouraged, a degree of collusion between companies in supplying the market. The special freight rates introduced by the Queensland Government have furthered this rationalisation of the distribution of sales areas.

In the Tariff Board Report referred to earlier it was stated: "The incidence of rail freights has the effect of dividing the Queensland market for cement geographically between the two producers.[3] However in spite of Queensland Cement and Lime's financial interest it is stated that there is competition in the fringe areas."[4]

From the evidence that has been studied it does not seem that this was ever the case and it certainly is not the case today. The method of

---

[3] This enquiry was held in mid 1961 at which time the Central Queensland Cement Pty. Ltd.was already marketing cement in Central Queensland! Admittedly the cement was from Darra but the marketing company was owned conjointly by the two "competitors" giving evidence before the Board of Inquiry.

[4] Tariff Board Report, 10th November, 1961 Department of Trade, Canberra, p.4.

marketing as described earlier does not allow any possibility of competition between the companies. The companies market their cement on the basis of fixed prices for the different classes of consumers, the consumer bearing the cost of transport. Competing wholesalers, or retailers, of the cement could presumably offer competitive prices for cement by altering the magnitude of their own margin of profit. Such adjustments in the final price of cement to the consumer could cause an adjustment to the boundaries of the areas supplied by the different companies. However such adjustments would be only minor variations on the boundaries agreed on by the companies and, in any case, this could hardly be construed as competition between the producing companies. But equally as important as the fact of collusion in explaining the absence of competition and the latitudinal division of the total market is the fact that was stressed in Chapter IV that there are three largely separate regional markets which were largely predetermined by the patterns of population distribution and railway lines in the state. The combined effects of distance, transport costs and tariff barriers effectively shield the Queensland cement producers from overseas competition. Almost the only imports of cement into Queensland since 1954-55 have been of special cements which, as was indicated at the outset, are outside the scope of this study. The oversea trade figures record only insignificant exports of cement from Queensland.[5]

---

[5] In the last three years however there have been small amounts of common grey portland cement imported into Queensland. The trade figures for the past 5 years are:

	1962-63	1963-64	1964-65	1965-66	1966-67	
Imports	nil	nil	245	450	829	tons
Exports	293	372	255	178	159	tons

(Source: Oversea Trade, Bulletins 60-64)

The situation with regard to interstate movements of cement is not as simple. The Queensland Cement and Lime Co. does supply cement in Northern N.S.W. as far south as Armidale but the company is unwilling to release the amount involved in this trade. In view of the fact that this company can compete against the N.S.W. producers in New England and Northern Rivers areas, it could seem reasonable to assume that the southern companies could not compete farther north in Queensland. This is not the case as some southern cement is imported even to North Queensland. The amount involved in these interstate imports can not be calculated but it has been suggested that it is a considerable amount.[6] Many graziers in Western Queensland have direct contact by road with Melbourne and Sydney. This is particularly true in the sheep rearing areas where wool is trucked to sales in these cities, and the freight rates on purchases from the south are very low or often non-existent. The difference between this trade and the normal method of supply of the Queensland market does not need to be elaborated. However, the conclusions that can be drawn from the rail transfer study as outlined in Chapter VIII would indicate that the railways are the main means of supplying markets in Western Queensland and that, as a result, other means of transport or outside sources of supply may be regarded as insignificant.

---

[6] This point was first raised by Mr.Besser, Sales Promotion Officer, North Queensland Cement Ltd. who believed these sales were important.

On the whole it does not seem that outside sales or outside imports are sufficiently large to invalidate the concept that has been used in this study of a virtually self-sufficient Queensland Market. Areally this market is seen to be tri-partite - or more accurately, it is seen to be three regional markets - served by three plants of an inter-related group of companies.

2. FEATURES OF THE LOCATION DECISION IN QUEENSLAND

As has been shown the three Queensland plants each occupy a central position in a separate regional market. Each is conveniently placed to serve that market, particularly the single large city in which the main concentration of demand is located. The situation of each plant may be seen as a pre-emptive bid to control the market or, at the least, the major concentration of demand. In each case the location of the plant is such that, while maintaining proximity to the urban area as the prime consideratinn, it gives ease of access to the limestone supplies. In the case of each of the new plants, this means location on the rail line to the limestone deposits and on that side of the city. In the case of the older Darra plant, the site was chosen for this reason but a change has been made to a closer source of lime accessible by water though on the other side of the city. In each case accessibility to coal supplies has been judged less important than accessibility to limestone, a fact easily explained by the relative weights involved.

In the case of each plant the selection of a near-urban site also guarantees the availability of labour and electric power, and both rail and road transport facilities are available at each site. There are also many other factors, usually grouped together as "urbanization economies", which are advantages that accrue from the choice of such a site.[7]

Quarrying operations at or very near to, each site produce the necessary clay or sand materials. At the Darra plant water is drawn from the Brisbane River; at the Stuart plant water is obtained from two dams the company has built on Stuart Creek; at the Parkhurst site the only water available at the outset was potable water from the Rockhampton town supply.

[7] J.Reeves, "Transport Costs and the Location of Industry in Victoria", Economic Record, Vol.27, 1951, p.235,has an interesting comment here. "Finally, in addition to measurable comparative costs, there are those intangible advantages which make the large city so attractive to intending manufacturers, such as close proximity to an established business environment, and to the facilities provided by trade associations and other commercial enterprises, close proximity to the best clubs and hotels and those other aspects of the modern business man's life." This should remind us that the location decision, no matter how rational, is still a human decision and subject to the whims, fancies or prejudices of the entrepreneur.

The generalizations stated here concerning features of the location decision in Queensland have been based on attempts to reconstruct the actual decisions and not on investigations of areally associated phenomena that are apparent today. The analysis has been of what was significant at the time of locating the plants and what has been significant in the continued development of the oldest plant. A recent study of alkali manufacture in Lancastria[8] contains an interesting discussion of methodological points which parallel those made in this study.

> "First, it is wise to be chary of an analysis which seeks to explain an historical event -- such as the founding of a factory -- in terms of the present-day environment for we should try to establish the conditions which prevailed when the original decisions were being taken.

---

[8] K.L.Wallwork, "Map Interpretation & IndustrialLocation: The example of Alkali Manufacture in Lancastria", Geography, Vol.53, 1968, p.p.166-181. This article was not sighted until after the main work of this study had been completed. The case studies on which it was based were probably contemporaneous with those undertaken here. Wallwork's comments on the methodology of location studies support contentions made in this study concerning the current "state of the art", and restate distinctions highlighted in this study as being necessary in this field of investigation.

Second, we should attempt to distinguish between those features which were responsible for the original choice of location and foundation of an industry and those which led to its subsequent expansion. Far too often the "factors of location" which we now deduce are "factors of successful development" and the two are not necessarily coincident. Finally we should note the difference between <u>general</u> location and <u>specific</u> location of industry. This is not merely a matter of scale of study for the precise siting of a plant may be of great significance not only to its success but also to the future development of the locality in which it has been placed."[9]

The deductions in this study concerning location optimums have been made after an analysis of significant input and output factors. However it has been necessary also to consider historical conditions as well as those of the present, the circumstances of supply and demand at the time of establishment of the plant, competition with other producers and the influence of government policies and actions. To ignore these latter would have been to make unreal assumptions about the rationality and generality of the location decision. But once these are included the study belongs distinctively and peculiarly to Queensland and it is realized that, in the case of the Queensland cement industry, there are two aspects

---

[9] ibid, p.167

of its nature which prevent the findings of the study being applied widely in an unmodified form.

First, the industry has been established in this state for approximately fifty years which is only the second part of the century-long story of cement. Fortunately this has meant that the situation is not confused by relict features from a past age: there are no sites of plants long since abandoned and there are no plants occupying obviously poor locations but persisting in production. On the other hand the brevity of the history of the industry has limited the number of plants to be studied and so limited the significance of the study and the generality of its findings.

Second, the Queensland market exists as a set of largely independent regional markets each separated from the other and each of a size that can be served by one plant in that market area. This has lessened the incidence of competition to virtual non-existence. As a result viability in the face of competition can not be used as a measure of suitability of location. Further only in a study of the oldest established plant is a consideration of long term viability possible.

An important result of a case study such as this is that, in its investigation within a particular physical, temporal and economic environment, it makes apparent the nature of the "noise" that can intrude into models attempting to describe the locational character of the cement industry today. In this study the conditions which make the conclusions peculiar to the Queensland cement industry are spelled out in the restricting assumptions of the model. Progress to more general conclusions can be made by relaxation of particular restricting assumptions. In this way confusion that has arisen in studies proceding from the investigation of large numbers of plants can be avoided as it is possible to recognize and account for unusually located plants: those established in poor locations and which will probably not be viable; those established for reasons which no longer apply but which have persisted in production; and those established under conditions of monopolistic competition and which may not be in the most economically-desirable locations.

However within the context of time and place as outlined above, several factors have been found to be most important in the location decision. Further, these factors can be ranked in order of priority in the location decision.

1. The cement industry in Queensland has been found to be primarily market oriented. This is the result of the operation of a number of influences. Basically there is the need to try to minimize the transport costs of moving to the market a great weight of a low value product. This is reinforced by the fact that the standardized nature of the product

means marketing on the basis of price alone and so distribution costs must be kept to a minimum. As the costs of marketing and distribution have risen over the years more than has the cost of raw materials it is observed that many industries exhibit increasingly a market orientation. The attraction of the main focus of the market to the majority of industries is a notable feature of the Australian scene in each State.[10] In Queensland this takes a special form with the special spatial distribution that applies here.

In each regional market in Queensland the population is concentrated in one predominant city, Brisbane, Townsville or Rockhampton. In each case this city is the focus of the rail routes of the region so that location near this city is at once both close to the main concentration of demand and in a convenient location to serve the rest of the market. The influences operating to produce market orientation are general enough in the cement industry in Australia, but the expression of this market orientation by the near-urban location of a single plant close to the main central point of each of the regional markets is a solution peculiar to Queensland.

2. This near-urban location has allowed certain relevant input factors to be regarded as ubiquities and so has efficiently removed them from the location decision, the chief among these

---

[10] See A.J.Robinson, "Regionalism and Urbanization in Australia", Economic Geography, Vol.39, 1963, pp.149-155.

factors being the availability of electric power and labour. Elsewhere than in Queensland these input factors <u>could be</u> truly ubiquitous and so a near-urban location would not be necessary. Also it is conceivable that in a less advanced society these factors would not be available even near a large city.

3. In choosing a general situation on the urban fringe of the main focus of the market the plants have been located to minimize transport inputs for coal and limestone and, due to the relative weights involved, the latter is more important.

4. Having found the general situation, the problem of the exact site was solved by the choice of an area of land where clay could be quarried and water obtained, and which had access to those relative ubiquities of a near-urban location - power, labour and transport facilities.

3. MARKET ORIENTATION

Although many geographers have recognized market orientation as a factor in the location decision, the concept has remained ill-defined or even ambiguous.[11] The importance for industry of proximity to market was stressed by C. D. Harris in 1954,[12] but there has been little definition of which industries are attracted, or of the mechanism of how they are attracted or finally, of why they are attracted to the market. Since 1954 most general economic geography texts have mentioned in passing Harris's conclusion about the increasing importance of the market, but there has been little improvement in the quality of the discussion of the market as a location factor. There is nothing in the discussion by E. Willard Miller in his 1965 text, a Geography of Manufacturing, that advances the concept beyond the level that could be attained by reading G.T.Renner's 1947 essay "Geography of Industrial Location" (Economic Geography, Vol.23).

In short, economic geographers are continuing to display the bias that McNee[13] described in 1959, a bias which complements what Isard called the "Anglo-Saxon bias" in economists. McNee pointed out that,

---

[11] This is a symptom of a widely recognized malaise of economic geography. See M.B.Ballabon, "Putting the Economic into Economic Geography", Economic Geography, Vol.33, 1957, or C.A.Fisher "Economic Geography in a Changing World", Transactions of the Institute of British Geographers, 1948, or D.M.Smith, "A Theoretical Framework for Geographical Studies of Industrial Location", Economic Geography, Vol.42, 1966.

[12] C.D.Harris, "The Market as a Factor in the Localization of Industry in the United States", Annals of the Association of American Geographers, Vol.44, 1954, pp.315-348.

[13] R.B.McNee, "The Changing Relationships of Economics and Economic Geography", Economic Geography, Vol.35, 1959, pp.189-198.

although both disciplines had expanded, the central interests of the past remained so that economics was still concerned with resource allocation and the market mechanism while economic geography was busy with <u>production</u> geography. Thus, although a useful body of economic theory has been in existence for over thirty years, it has yet to make its appearance in general economic geography texts.

There are several points which are usually made in any discussion of market orientation. It is usually stated that nearness to market is important in industries where the raw materials are markedly increased in bulk or weight during the processing, where the process creates a perishable or fragile product or where personal contact with the market is necessary because the product is one for which popular interest, fashion, style or technological character are important. The advantages of a near market location also can be the result of the utilization of ubiquitous raw materials or of differentials between freight rates for raw materials and for manufactured goods. It is sometimes stated that market orientation results from the inability of low value goods to bear the costs of transport. Finally there are often mentioned those points related to the transport of goods to market: the importance of terminal locations or trans-shipment point locations or of location at a point strategic for the serving of the market.

The location analysis carried out in this study has made obvious certain points about the nature of the attraction of the market and the way in which it acts as a location factor. The points made obvious are certainly not original discoveries but it is felt that they warrant some attention in view of the many unsatisfactory treatments of this concept in geographic texts.

First such concepts as "nearness to market" can not simply be given the dimension of distance. What is important is the <u>cost</u> of getting the good to market and so "nearness" must be defined in term of cost. Second as the market is not a punctiform one then the idea of "nearness" must be further modified to mean the cost of serving the different parts of the market. It is at this stage of the location decision that the general <u>situation</u> of the market-oriented plant is determined. Third, the general inaccuracy of the statement concerning value per unit of weight should be recognized. (This point was discussed in Chapter III, pages 60 and 61). Fourth, there is the need to consider the realities of freight rate structures. Though this point often is satisfactorily treated its fundamental importance makes it desirable to stress that usually freight rates differentiate between commodities, are less than proportional to distance and have high terminal block charges. Fifth, reinforcement of the tendency to market orientation occurs when a centre of demand is also a large urban centre. Sixth, there is another factor which is not generally mentioned but which in many cases should be ranked first in importance above those factors which are.

Entrepreneurs, in seeking a market location for their plants, are able to attain monopolistic dominance of some portion of the market. They can ensure dominance over some quantity of demand and so ensure a continued outlet for the goods produced. If it is possible the plant will be located as close as practicable to the major concentration of demand in the market area. When many plants are involved this can give rise to the widely observed tendency for competitors to cluster. In the case of imperfect competition the different plants will be located so that the market may be shared between them. It is the absence of reference to location under conditions of imperfect competition that is felt to be the major inadequacy in description by geographers of market orientation.

It has been argued throughout this study that location analysis needs to proceed at two levels since different factors operate to determine situation and to determine site. It has further been argued that market orientation acts to determine situation. Greenhut[14] has argued beyond this that although demand can be an "area-determining factor of location", "in the second instance, we find that

---

[14] M.L. Greenhut, "When is the Demand Factor of Location Important?", Land Economics, Vol.40, 1964.

after some roughly designated market area is selected, the particular site may be chosen on the basis of demand differentials throughout the area".[15] Greenhut also pointed out that this fact has been ignored by American and other location empiricists and he suggested the recognition of the "site-demand factor", "an independent factor in much the same position as labour or transportation".[16]

With an economist's view of the market mechanism, Greenhut maintains that demand can not be regarded as a constant in the location decision since demand depends upon location. Here his article becomes less satisfactory as his undefined and loosely used term demand seems at one moment to refer to aggregate demand for the total market area and at another to refer to that part of the total demand which can be satisfied by the plant in question. Although Greenhut maintains that demand can be a site factor he does not deny its operation as a situation factor and it seems that any contradictions between his position and that adopted in this study is more apparent than real. Further it is probable that in a case such as has been studied here with a low density market and a few large scale plants that demand differentials at the site level are insignificant.

---

[15] ibid, p.177
[16] ibid, p.178

On the other hand it is important to remember Greenhut's basic point that variations in demand can occur with shifts in location of the producing unit whether or not such shifts are of the magnitude of changes in situation or only changes in site. One of the most useful contributions to this area of investigation is in the models of E.W.Orr[17] which also can encompass variations in transport rates related to the variations in demand for transport services in turn caused by the variations in regional patterns of demand.

Although Orr's "transport-demand curve" is of little significance in this State where a government monopoly on rail transport sets arbitrary freight rates, Orr's models make apparent the facts that regional price levels affect, and are affected by, the location pattern and transport costs. The majority of Orr's work, although very useful, is not of direct relevance to the problem of market orientation that is under discussion here. However his models do make obvious the relationship between regional price levels and the marginal costs of plants which determines whether or not a plant may establish in a region. They make obvious that there is a threshhold level of demand below which a plant can not be established, the exact level being set by the regional price level. If

---

[17] E.W.Orr, "A Synthesis of Theories of Location, of Transport Rates and of Spatial Price Equilibrium", Papers & Proceedings, Regional Science Association, Vol. 3, 1957.
Orr's models were the basis of that used in the derivation of the first and third thesis propositions.

the price is low then only a large scale plant with low marginal costs could establish there economically. If the price is high then a smaller scale plant with a higher marginal cost curve could be contemplated. This means that the economies resulting from large scale production act to prevent geographic diversification of production even in industries where plants are usually market oriented. As has been shown in the Queensland case studied here, the establishment of plants in the market area has to await the growth of demand to an adequate level, the level being related to the prevailing price set by the trade carried on to serve that market area.

4. CONCLUSION

" .... no one seems to know exactly what the conditions of cement production are, nor why the industry is located where it is."

Even if we allow for the exaggeration in Lukerman's statement, it is still disquieting. Surely in the case of one simple industry composed of a relatively small number of fairly large scale plants, geographers should find it possible to reach some degree of certainty on these matters.

In the second chapter a research strategy proposed by McCarty was outlined. The prime need, suggested McCarty, was for case studies as the result of which some small contribution could be made to the body of theory of economic geography. This research strategy provides perspective for the study undertaken here. In this study an attempt has been made to investigate the location of the three plants engaged in producing cement in Queensland. Each of the three case studies revealed the variety of combinations of factors involved in the establishment of a plant and the wide range of substitution possibilities that may be present even in the production of a homogeneous product in a limited number of establishments in one area under roughly parallel economic conditions. The knowledge of this complexity compels the conclusion that no claim can be made for the broader applicability of the findings of this study in an unmodified form. However, in the words of J. S. Mill, "Knowledge insufficient for prediction may be most valuable for guidance".

The generalizations regarding location factors operative in the Queensland cement industry are offered as a hypothesis, highly restricted both topically and areally, to explain the existing patterns of the industry. The only way to move with certainty to the formulation of a broader and more generally applicable hypothesis would be by conducting other analyses similar to this one and by correlating the findings of each of these. In this way geographers can avoid the confusion that is made obvious in the conflicting statements which were quoted in the introductory chapter. As was pointed out, these conflicting statements were not wrong but only incomplete: they did not specify the time and place in which such generalizations would be correct, nor did they specify distinctions between situation and site in their description of locations. Similarly the views generally expressed about market orientation are less wrong than incomplete: they usually omit reference to the limited competition and local monopoly situations which are the rule rather than the exception in economic activity; and they usually do not consider realistic rate structures, although transfer costs are the fundamental determinant of industrial orientation.

This location analysis, as well as being an idiographic study complete in itself, is also the first section of a nomothetic procedure. The themes of this study could be developed from other such studies to allow greater and more accurate generalization about cement plant location. At a higher level of abstraction they could be part of a broader study of location under conditions of imperfect competition in industries with an oligopolistic or a monopolistic structure. Equal importance must therefore be attached to both the descriptive material and the results of analysis. The general theoretic statements which are the outcome of this study have been presented, not as the conclusions drawn from a deductive process of reasoning, but as a thesis to be argued through this study. It is now claimed that this thesis has been fully substantiated. The derivation of the thesis from axiomatic structures has been shown and the applicability of each proposition of the thesis has been demonstrated and, if this has been done satisfactorily, then it will be pessible - for Queensland at least - "to know exactly what the conditions of cement production are" and "why the industry is located where it is."

SELECT BIBLIOGRAPHY

A. METHODOLOGY

Ackerman, E.A. — Geography as a Fundamental Research Discipline, University of Chicago, Department of Geography, Research Paper No.53, 1958.

Ballabon, M.B. — "Putting the Economic into Economic Geography", Economic Geography, Vol.33, 1957.

Fisher, C.A. — "Economic Geography in a Changing World", Transactions of the Institute of British Geographers, 1948.

Hartshorne, R. — Perspective on the Nature of Geography, Association of American Geographers, Rand McNally, Chicago, 1959.

McCarty, H.H. — "An Approach to a Theory of Economic Geography", Economic Geography, Vol.30, 1954.

McNee, R.B. — "The Changing Relationships of Economics and Economic Geography", Economic Geography, Vol.35, 1959.

B. INDUSTRIAL LOCATION - General and Theoretical

Alexander, J.W. — Economic Geography, Prentice Hall, New Jersey, 1963.

Beaver, S.H. — "The Localization of Industry", Geography, Vol. 20, 1935.

Estall, R.C. and Buchanan, R.O. — Industrial Activity & Economic Geography, Hutchinson, London, 1961.

Greenhut, M.L. — "When is the Demand Factor of Location Important?" Land Economics, Vol. 40, 1964.

Harris, C.D. — "The Market as a Factor in the Localization of Industry in the United States", Annals of the Association of American Geographers, Vol. 44, 1954.

Hartshorne, R. — "Location as a factor in Geography", Annals of the Association of American Geographers, Vol. XVII, 1927.

Isard, W. — Location and Space-Economy, Technology Press of the Massachusetts Institute of Technology, John Wiley and Sons, New York, 1956.

Losch, A. — The Economics of Location, tr. by W. Woglom, Yale University Press, New Haven, 1954.

McMillan, T.E., Jr. — "Why Manufacturers Choose Plant Locations versus Determinants of Plant Locations", Land Economics, Vol.41, 1965.

Orr, E.W. — "A synthesis of Theories of Location, of Transport Rates, and of Spatial Price Equilibrium", Papers and Proceedings, Regional Science Association, Vol. 3, 1957.

Rawston, W. — "Three Principles of Industrial Location", Transactions of the Institute of British Geographers, 1958.

Smith, D.M. — "A Theoretical Framework for Geographical studies of Industrial Location", Economic Geography, Vol.42, 1966.

Smith, W. — "The Location of Industry", Transactions of the Institute of British Geographers, 1955.

Weber, A. — Theory of the Location of Industries, tr. by C. J. Friedrich, University of Chicago Press, 1929.

C. THE CEMENT INDUSTRY

(i) References in general economic geography texts:

Aldefer, E.B. and Michl, H.E. — Economics of American Industry, (3rd ed.), McGraw Hill, New York, 1957.

Bengston, N.A. and Van Royen, W. — Fundamentals of Economic Geography, Prentice Hall, New York, 1956.

Ekblaw, S.E. and Malkerne, D.J.D. — Economic and Social Geography, McGraw Hill, New York, 1958.

Highsmith, R.M. and Jensen, J.G. — Geography of Commodity Production, J.B.Lippencott, Chicago, 1958.

Miller, E. Willard — A Geography of Manufacturing, Prentice Hall, Englewood Cliffs, N.J., 1957.

Renner, G.T., Durand, L., Langdon, C. and Gibson, W.B. — *World Economic Geography*, Crowell, New York, 1957.

Smith, J.R., Phillips, M.O. and Smith, T.R. — *Industrial and Commercial Geography*, Holt, New York, 1955.

(ii) Other references:

Burn, D., editor, — *The Structure of British Industry*, Cambridge, 1957.

Hildebrand, W. — "The Cement Industry", *Development of American Industries*, editors J.G.Glover and W.B.Cornell, Prentice Hall, New York, 1949.

Lea, F.M. and Desch, J. — *The Chemistry of Cement and Concrete*, E. Arnold, London, 1956.

Loescher, S.M. — *Imperfect Collusion in the Cement Industry*, Harvard University Press, Cambridge, 1959.

Lukerman, F. — "The Geography of Cement?", *The Professional Geographer*, Vol.XII, No.4., July 1960.

D. CEMENT IN AUSTRALIA.

Forster, C. — *Industrial Development in Australia, 1920-1930*, Australian National University Press, Melbourne, 1964.

Gough, M., Hughes, H., McFarlane, B.J. and Palmer, G.R. — *Queensland: Industrial Enigma*, Melbourne University Press, Melbourne 1964.

Hogan, W.P. — "The Structure and Development of the Australian Cement Industry, 1949-50 to 1959-60: A Preliminary View", Paper read at Section G, A.N.Z.A.A.S. Conference, Brisbane 1961.

Hunter, A., editor, — *The Economics of Australian Industry*, Melbourne University Press, Melbourne, 1963.

Kindler, J.E. — "Engineering Structures in Queensland, 1951-60", Introducing Queensland, Australian and New Zealand Association for the Advancement of Science, Brisbane, 1961.

Lengyel, S.J. and Beecroft, R.M. — The Cost of Distribution of consumption goods in Australia and elsewhere, Faculty of Economics & Commerce, University of Melbourne, 1949.

Reeves, J. — "Transport Costs and the Location of Industry in Victoria", Economic Record, Vol. 27, 1951.

Robinson, A.J. — "Regionalism and Urbanization in Australia: A note on locational emphasis in the Australian economy", Economic Geography, Vol.39, 1963.

Shiel, G. — Chemical Industries in the Rockhampton Area, Rockhampton and District Development Association, Rockhampton.

----- — Investment Service, Research and Statistical Bureau, Sydney Stock Exchange.

----- — History, Production and Utilization of Cement in Queensland, Queensland Cement and Lime Co., Brisbane, 1951.

----- — Annual Reports, Queensland Cement and Lime Co.

----- — Annual Reports, North Australian Cement Ltd.

E. OFFICIAL PUBLICATIONS

(i) Queensland:

----- — Queensland Government Gazette (various years)

----- — Queensland Government Mining Journal (various years)

----- — Queensland Parliamentary Debates (various years)

----- — Queensland Parliamentary Papers (various years)

----- *Queensland Year Book* (various years)

----- *Reports of the Director of Secondary Industries and Chairman of the Industries Assistance Board*, years 1956 to 1963.

----- *Reports of the Under-Secretary for Mines* (various years)

----- *Statistics of Queensland* (various years)

(ii) *Commonwealth of Australia*:

----- *Developments in Australian Manufacturing Industry*, Department of Trade, years 1948-63.

----- *Manufacturing Industries*, No.1, Cement and Cement Goods, Bureau of Census and Statistics (various years)

----- *Oversea Trade*, Bureau of Census and Statistics, years 1908-67.

----- *Tariff Board Report*, 10th November, 1961, Department of Trade.

----- *Secondary Industries Bulletins*, Bureau of Census and Statistics, (various years)

----- *Parliamentary Papers*, (various years)

APPENDIX 1

Brief extracts from articles and reports dated 1913 and 1914 by Mr. B. Dunstan, Queensland Government Geologist

Reference was made in Chapter II and on Map II to the activity of the Government Geologist in conducting survey work on the availability of cement materials in Queensland. Because Mr. Dunstan's speculations on the location of a cement plant were not directly relevant to the decision made for the Queensland Cement and Lime Co., no details were mentioned in Chapter II. However some reference should be made to them for their interest,

(a) as an example of a partial location analysis made in 1914, and

(b) for comparison with the decision to build a works at Darra.

Throughout this study the dominance of market orientation has been stressed. The alternative suggestions made here come from a man whose interest was in the raw materials and whose location considerations were raw material oriented.

* * * * *

In "Portland Cement Manufacture in the Maryborough District", (*Queensland Government Mining Journal*, Vol.XV, July 1914, p.355), Mr. Dunstan says: "In the Maryborough District the ingredients for the manufacture of Portland Cement are to be found in a number of localities, close to railway lines at varying distances from Maryborough and from the deepwater port now being constructed at Urangan, the terminus of the Pialba railway line at Hervey Bay." He considers the availability of limestone at the deposits shown on the accompanying diagram.

He continues "Clay shale which usually furnishes most of the silica and alumina necessary in the Portland Cement mixture, is of common occurrence, and many places in the Maryborough district can furnish the necessary supplies."

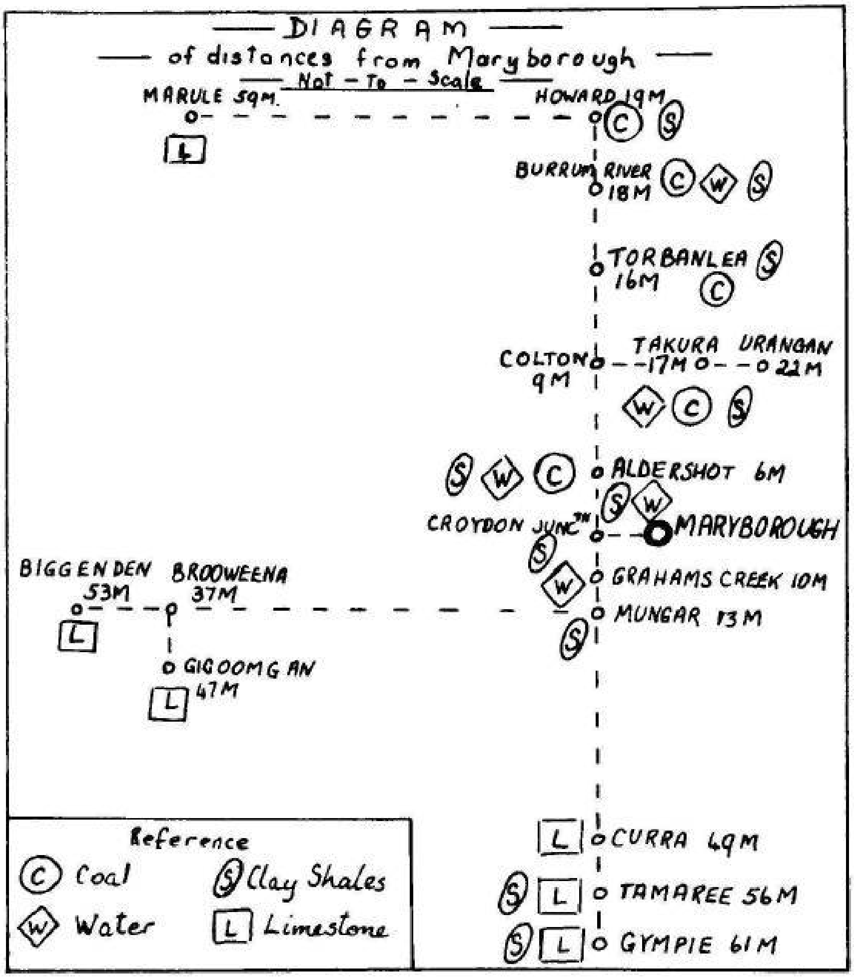
"Coal supplies, of which large quantities will be required in the manufacture of cement will have to be obtained from the mines at Howard, Torbanlea, Burrum River or Burgowan, or from Aldershot ....."

"A good supply of water is an important adjunct to a portland cement works and the want of this is, perhaps, the weak spot in the Maryborough propositions. A large supply is not available near the city unless the city supply is to be utilized." Some of the possible locations were Aldershot, where there was a dam on Saltwater Creek, Dunthandu, Takura on Stockyard Creek on the Colton-Urangan line or Burrum River.

"Regarding sites for works, an ideal position would be where railway and waterway are both in the vicinity and these conditions would prevail in several places about Maryborough." He suggests the most favourable sites close to Maryborough to be Aldershot, Croydon Junction and Dunthandu. Takura could be satisfactory as coal could be found in the area and water was available. Burrum River would be favourable if the Marule limestone was used while either Graham's Creek or Mungar would be favourable if Biggenden or Curra limestone was used.

"In conclusion it can very confidently be stated that in no other locality in Queensland, with the possible exception of Gladstone, do the limestone coal and shale deposits exist so close together and convenient to a deepwater port as in this district, and every encouragement can therefore be given to the establishment of a portland cement industry."

In the annual report of the Mines department for 1913, and in the Mining Journal in August, the Government Geologist reported on other limestone deposits that had been assessed as well as those in the Maryborough district. Amongst these other deposits were three in the Rockhampton area - Raglan, Ambrose and Mt. Etna (The Caves) - and two in the Warwick district - Gore and Silverwood.



Tracing of a diagram illustrating "Portland Cement Manufacture in the Maryborough District"

Queensland Government Mining Journal Vol.XV, July 1914, p.356

APPENDIX 2

Limestone deposits in South-east Queensland

The deposits of limestone in the "Maryborough district" referred to in Appendix 1 are part of a very extensive series of upper Palaeozoic sedimentaries which have been traced from Gympie to Gin Gin. Dunstan (1914) says the deposits "form a conspicuous horizon in the Middle Gympie Formation of the Permo-Carboniferous system" and traces their outcrops from Traveston to Rosedale. "The length of the belt is over 100 miles and along its outcrops there are enormous quantities of limestone of first class quality suitable for making lime and portland cement and for fertilizing lands on agricultural farms."

Analyses of the principal deposits investigated appear in the table below. It will be noted that the deposits closest to Brisbane (Gympie and Tamaree) are of very low grade. The best deposits analysed were at Mundubbera and Biggenden.

The deposits of limestone in the Warwick district are older Silurian or Devonian deposits forming part of the Texas Block - the northern end of the Great New England Palaeozoic Block. In his article on the Silurian rocks of the Border Rivers area K.G.Lucas says:

> "Older Palaeozoic low grade metamorphic sedimentaries, some of which may be Silurian, outcrop fairly extensively between Warwick and Inglewood in an arc, fifty miles across, whose concave southern side swings around younger Palaeozoic sedimentaries. The whole outcrop is bounded from east to south-west by late Palaeozoic granitic bathyliths and to north and west by post-Palaeozoic deposits. Outcrops of these

rocks west of the Silverwood area were called Bald Mountain Jaspers by Richards and Bryan (1926)"

Lucas suggests that the formation may be broadly subdivided. The oldest rocks are low grade metamorphics called <u>Thanes Creek Slate</u> regarded as equivalent of Neranleigh-Fernvale rocks of the Brisbane area. The formation includes also lenticular deposits of pale limestone. "Jasper - limestone horizons occupy the upper part of the formation in the Cement Mills area where they may be 5,000 feet thick. The bottom of the formation is unknown but the exposed parts of the jasper may attain 15,000 feet."

"Indeterminate <u>Rugose</u> corals and algae? have been obtained from the limestone belts of the formation. <u>Alveolites</u> sp. (Silurian-Devonian) has been identified in limestone from "Cooinoo". <u>Heliolites</u> sp. (Ordivician-Devonian) is reported from the limestone at Cement Mills but the specimen is lost. If the limestone is Devonian (perforce Lower Devonian i.e. pre-Silverwood) then only the underlying uniform dark slate and sandstone may be regarded as wholly or partly Silurian."

The "Cement Mills" referred to is the quarry site near the Gore railway station and is the Gore limestone deposit referred to elsewhere in this study. "Cooinoo" is a nearby homestead.

To the east of these extensive beds of massive limestone are the deposits of the Silverwood area. As the following table shows they are of almost as high grade as the Gore deposits but they occur in smaller lenses.

The company statement regarding the selection of Gore as the quarry site was quoted on p.49. The statement that there was "no processible limestone in sufficient quantities nearer than Gore" points out the three main aspects to be considered - the quality of the limestone, the size of the deposit and the distance from Darra. It will be seen from the analysis figures given in the attached table that the Gore limestone was of high quality and that the only equally good limestones were those at Silverwood, at Mundubbera or in the Rock-hampton area. The first-mentioned were not in sufficient quantities and the others were not nearer than Gore. The deposits at Biggenden and Marule though of slightly lower grade could still have been used but they possessed no advantage in proximity. The Tamaree deposit which was being worked was actually the best quality limestone near to Brisbane but it was a very small deposit and this presumably is why it was not selected.

Of the available limestone deposits Gore represented the closest of the high quality large-scale deposits, given that the cement plant would be close to Brisbane.

A2(iv)

LIMESTONE ANALYSES

Locality	Moisture	Loss on Ignition	Silica	Iron Oxide	Alumina	Lime	Magnesium	TOTAL
Ambrose	0.1	42.6	1.0	0.5	0.7	55.1	0.1	100.1
Biggenden (Morish's)	-	41.7	2.8	0.9	1.1	53.0	0.1	99.6
Biggenden (Morish's south)	0.1	37.0	10.1	1.5	3.8	46.1	0.6	99.2
Biggenden (Watson's)	0.1	39.3	6.7	1.0	2.2	48.9	0.6	98.8
Curra	-	40.5	5.1	0.8	0.8	51.1	0.2	98.5
Daylesford	1.5	43.3	5.1	3.4		46.9	Trace	100.25
Glenmore	0.1	42.5	1.5	0.3	0.7	53.9	0.5	99.5
Gore	Trace	43.4	0.4	0.1	0.1	58.9	nil	99.9
Gympie Cemetery (1)	-	-	37.6	3.1	4.0	-	-	-
" " (2)	-	-	35.0	1.1	2.1	-	-	-
" " (3)	-	-	28.1	1.4	2.5	-	-	-
Malchi Creek (Rockhampton)	1.0	42.1	2.9	Trace	0.8	52.0	1.2	100.0
Mortar Island	0.2	42.9	1.9	0.7		54.6	-	-
Mt.Etna (Near Hotel)	0.2	42.1	1.7	0.3	0.9	54.1	0.3	99.6
" " (Olsens Caves)	Trace	41.6	2.5	0.3	1.2	53.8	0.2	99.8
Mundubbera	-	43.4	0.3	Trace	0.2	56.0	-	99.9
Raglan (1)	-	42.9	0.9	0.2	0.5	55.0	0.2	99.7
" (2)	-	42.8	0.8	0.1	0.2	55.4	0.1	99.4
" (3)	-	38.8	8.1	1.2	2.4	49.0	0.6	100.1
Silverwood (Lock's)	0.1	42.6	0.9	0.3	0.6	54.2	0.2	98.8
" (Reeve)	-	42.6	0.8	0.3	0.9	54.1	0.2	99.0
Tamaree (working)	-	42.1	2.6	0.3	0.8	53.3	0.4	99.5
" (idle)	-	36.3	13.5	0.9	1.7	45.5	0.4	98.3
" (blue rock)	0.2	32.2	21.8	1.3	2.6	40.5	0.5	99.1
" (3 miles S.W.)	0.5	23.1	38.0	2.1	4.8	29.6	0.1	98.0
Marule (Willie Creek)	0.5	37.2	11.7	0.8	2.3	47.0	0.5	100.0
" (Cliff Section)	-	37.0	12.1	1.7	1.8	47.2	0.9	100.7
" (outcrop-Sandy Creek)	0.9	33.1	15.4	2.6	4.0	43.1	0.9	100.0

SOURCE: Queensland Government Mining Journal, Vol. XV, August 1914, p.419.

APPENDIX 3

Extracts from reports on cement tariffs

1. Interstate Commission of Australia, Tariff Investigation, June 1915, Portland Cement.

Parliamentary Papers, 1914-17, Vol. VII, pp.1418 ff.

The Managing Director of Goodlet & Smith said "We do arrange and fix prices with the Commonwealth Portland Cement Company" .... "As a general rule, before tendering, we agree to quote the same price." (p.1423)

The local Secretary of Commonwealth Portland Cement Company said "We always regulate our price with the selling price of imported cement. We maintain it is the imported cement that fixes the price". (p.1423)

	Origin	
	Continental	United Kingdom
F.o.b. cost per cask (6 casks per ton)	5s.	5s.
Freight and other charges	3s. 6d.	4s. 3d.
	8s. 6d.	9s. 3d.
Duty	3s. 4d.	2s. 6d.
	11s. 10d.	11s. 9d.
Thus, freight etc.as % of f.o.b. value	70%	85%
Thus, duty as % of f.o.b. value	66.7%	50%

(p.1423)

The Commissioners realized that:
"The industry is one which can only be profitably carried on by large concerns, and, therefore, the production of all the Australian requirements will be limited to a few companies only. The position, therefore, is one in which it is comparatively easy to organize a monopoly, as has been done in N.S.W. where there are only two enterprises."

The Commissioners recommended:
"There is therefore only one way to provide for the prosperity of the existing and contemplated enterprises and at the same time for cement being sold at a reasonable price and that is to reduce the duty." (p.1424)

Augustus Cecil Elphinstone, General Manager of the Queensland Cement and Lime Company, gave evidence on 24th September 1914.

"The public has been induced to subscribe on the grounds that the duty is £1 on foreign and 15/- on British cement."

"Even with the existing Tariff it is almost impossible to compete with the imported cement at Townsville".

"The freight from here to Townsville is 22/6 a ton while from Hamburg to Townsville it is 17/6 a ton." (p.1452)

"The cost of manufacturing cement is largely a question of freight".

Extracts from the abridged Prospectus for the Company

Estimated for 30,000 tons of cement

Limestone at factory	£24,300
Coal " "	5,625
Clay & Shale " "	1,500
Repairs etc.	1,500
Labour etc.	8,250
Bags	9,000
Management etc. & Depreciation	6,250
	£ 56,425

which is equal to a price of 37/7 a ton at factory or 40/1 a ton in Brisbane.

A Continental Company had guaranteed, under a penalty of £10,000, that their plant would make cement at Darra for 35/- or for 37/6 in Brisbane for an annual production of 30,000 tons.

4 The demand is assured , the consumption in Queensland during 1913 being 36,000 tons, and increasing rapidly, whilst the company's output in 1915 will only be 30,000 tons.

5 The present wholesale net price of cement on wharf in Brisbane is 74/8 per ton; the lowest price during the last five years is 68/3½. The cost of the company's cement delivered in Brisbane is estimated at 40/1. Under the most unfavourable conditions known in the past 5 years there would be a margin of 28/0½ per ton on cement sold in Brisbane. (p.1453)

2. Tariff Board's Report on Portland Cement. 22nd March, 1935.

Parliamentary Papers, 1934-37, Vol.2.pp.2305ff.

The Board criticized aspects of the industry such as the amount of excess capacity and the prevalence of price fixing. The tariffs were again reduced.

The capacity of installed plant in 1934 was	1,300,000 tons
Peak demand in 1927-28 was	75,000 tons
During the depression demand was	250-300,000 tons
Expected annual demand 1936-39 was	600,000 tons

The Board "found abundant proof that the price at which some manufacturers are selling cement returns a very high profit on the capital invested in the industry."

Profits ranged from 6% to 32% on capital

Output ranged from 16% to 74% of capacity and the weighted average was $33\frac{1}{3}$%

Profits ranged from 9/10 to £2. 0. 6. per ton of cement.

The average selling price was £3.10.0. per ton. In the case of the Queensland Cement and Lime plant the Board found "the cost of transporting limestone from the quarry to the works per ton of cement exceeds the cost of shipping cement from Sydney to Brisbane. The Board understands, however, that the company proposes to reduce its costs under this head by obtaining its calcareous material from a coral deposit in Moreton Bay." The Board suggested that a reasonable selling price in Brisbane would be £3. 3.10. per ton.

Supplementary Report

Selling prices in Australia ranged from £3. 5. 3. to £5. 0.11. compared with £2. 0. 0. in Canada or £2. 7. 6. in the United Kingdom. "To illustrate the undue disparity between Australian and United Kingdom prices, the Board took the selling price charged by one Australian manufacturer situated close to a capital city and distant from its sources of coal and limestone; this price reduced by the whole costs of coal and limestone gives a figure which is more than twice the domestic price of cement in the United Kingdom; in fact, the profit per ton alone exceeded the domestic price of cement in the United Kingdom".

The Board reached the following conclusions:

"(a) The industry was over-capitalized and that plant far in excess of existing or immediate prospective needs had been installed.

(b) The rationing of output between manufacturers during the depression hindered free competition, and by keeping output at a low percentage of the capacity of individual plants, increased costs of production.

(c) The profits made by the manufacturers as a whole were unreasonably high."

"The duty and other charges on imported cement assisted the manufacturers to maintain this relatively remunerative position during the depth of the depression and the Board concluded that the only way in which the manufacturers could be forced to reduce prices to a reasonable level was to reduce the duty on importations."

"The high costs (of manufacturing) in all the factories, and the extremely high costs in some of them, are due no doubt to very low output in relation to capacity but the Board considers that the industry provides a useful example of a drift to comparative inefficiency caused by the absence of free local competition."

(3) Tariff Board Report on
Portland Cement from Japan ---
Dumping & Subsidies. 10th November 1961

The high rail freight component in the retail price of cement sold to North Queensland, together with the fact that demand was considered sufficient to justify a small production unit in the area, led to the establishment of North Australian Cement Limited's plant at Stuart. The company was formed in 1948 and production began in 1954. (p.3)

North Australian Cement Ltd. employs 144 persons and also provides extensive indirect employment in its purchase of raw materials.

"The incidence of rail freights has the effect of dividing the Queensland market for cement geographically between the two producers. However in spite of Queensland Cement and Lime's financial interest it is stated that there is competition in the fringe areas."

"Consumption of cement in Central Queensland has increased to the point where construction of a cement plant in that area is intended. As a preliminary step Queensland Cement and Lime and North Australian Cement Limited have jointly undertaken the investment of £300,000 in the establishment of a clinker grinding and cement packing plant at Rockhampton".

APPENDIX 4

Rail Transfer of Cement

The following maps and diagrams show consignments from three stations for the three financial years up to June 1966. The three stations are those from which cement is consigned by the three cement works. The Queensland Cement and Lime Coy. plant dispatches its cement through the adjacent Darra station and the North Australian Cement Ltd. plant uses the adjacent Stuart station. Elsewhere in this study the plant of the Central Queensland Cement Company has been referred to as the Parkhurst plant or simply as Parkhurst. However the railway station of Parkhurst is a half-mile to the north of the plant and the plant has its own siding known as 402 miles 57 chains (north of Roma Street Station) and another siding another half-mile south at 402 m. 19 ch. where the company first began operations marketing cement from Darra or Stuart. To avoid confusion the name Parkhurst has been used on these maps to refer to the siding at the cement works.

It must be noted that the maps show total consignments from these stations and not just consignments of cement. It has been explained for the Darra station (see Table 9) that the errors involved in considering total consignments as consignments of cement or clinker are very small. The situation is very simple at siding 402 m. 57 chs. as here cement was the only commodity railed away.

The statistics available for consignments from Stuart are more difficult to deal with than are those from the other two stations. The difficulty arises from the large quantities of goods other than cement consigned from Stuart in the first two years of the period under investigation. However in the final year cement and clinker consignments made up 97% of the total for all goods, a situation similar to that at Darra.

Consignments from Stuart

			1963-64	1964-65	1965-66
(a)	Cement	(tons)	65,661	63,622	51,090
(b)	Clinker to Parkhurst	"	nil	nil	4,882
(c)	Total N.A.Cem.Ltd. (a & b)	"	65,661	63,622	55,972
	welded rails	"	18,248	6,954	...
	not specified	"	12,439	3,018	...
(d)	Class: Other Minerals	"	96,348	73,595	56,822
	sawn timber	"	10,182	1,278	...
(e)	TOTAL: ALL GOODS	"	106,990	75,228	58,263
(f)	(c) as % of (e)		61%	85%	97%

As can be seen from the table, in 1963-64 less than two-thirds of the tonnage of goods consigned from Stuart was cement. At this time, and until the completion of the Mount Isa rail project, Ford Bacon & Davis Inc. maintained a depot at Stuart. Here the rails for the new line were welded into long lengths and dispatched to work sites along the line. Eighteen thousand tons of welded rails were consigned from Stuart in 1963-64 and seven thousand tons in 1964-65. The other large tonnages included in the class "other Minerals" are not specified but there were some references to ballast, to cement blocks and to old rails. It is very difficult to separate these but since only 100 tons of cement blocks were actually noted and as the greater part of this unspecified commodity attracted very little freight then it is assumed that it was largely ballast. However in only one case (1670 tons to Nome, October 1964) was ballast actually specified. The old rails were sold for scrap but it is difficult to see any evidence in the available figures of large amounts of these being consigned from Stuart.

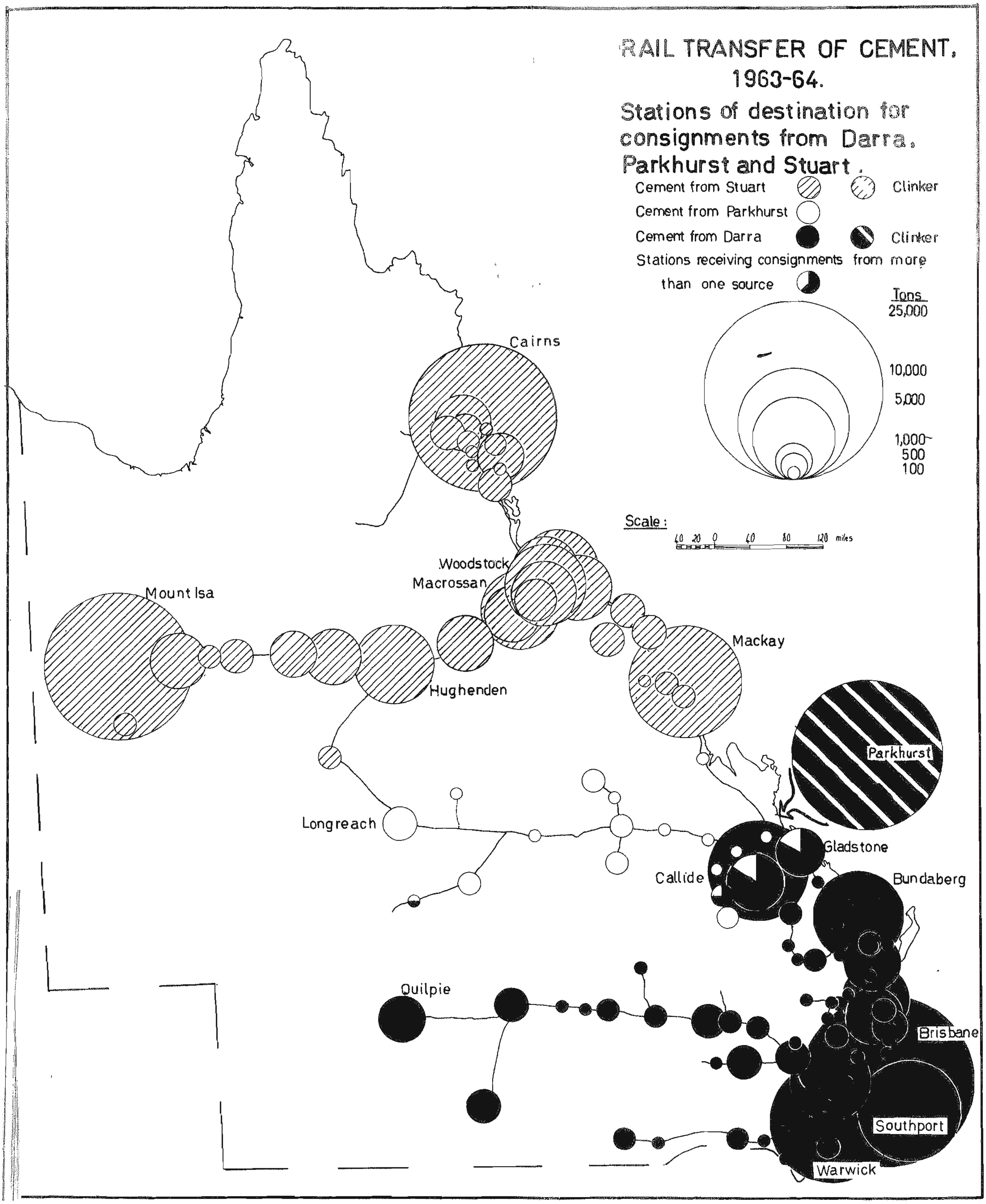
The commodity responsible for most of the difference between the class "Other Minerals" and the total "All Goods" was entered in the column "Sawn Timber" with the note "Sleepers" added to it. A certain amount may have been sawn timber other than sleepers, e.g. pit timber for mines, but presumably most of it was destined for the rail project.

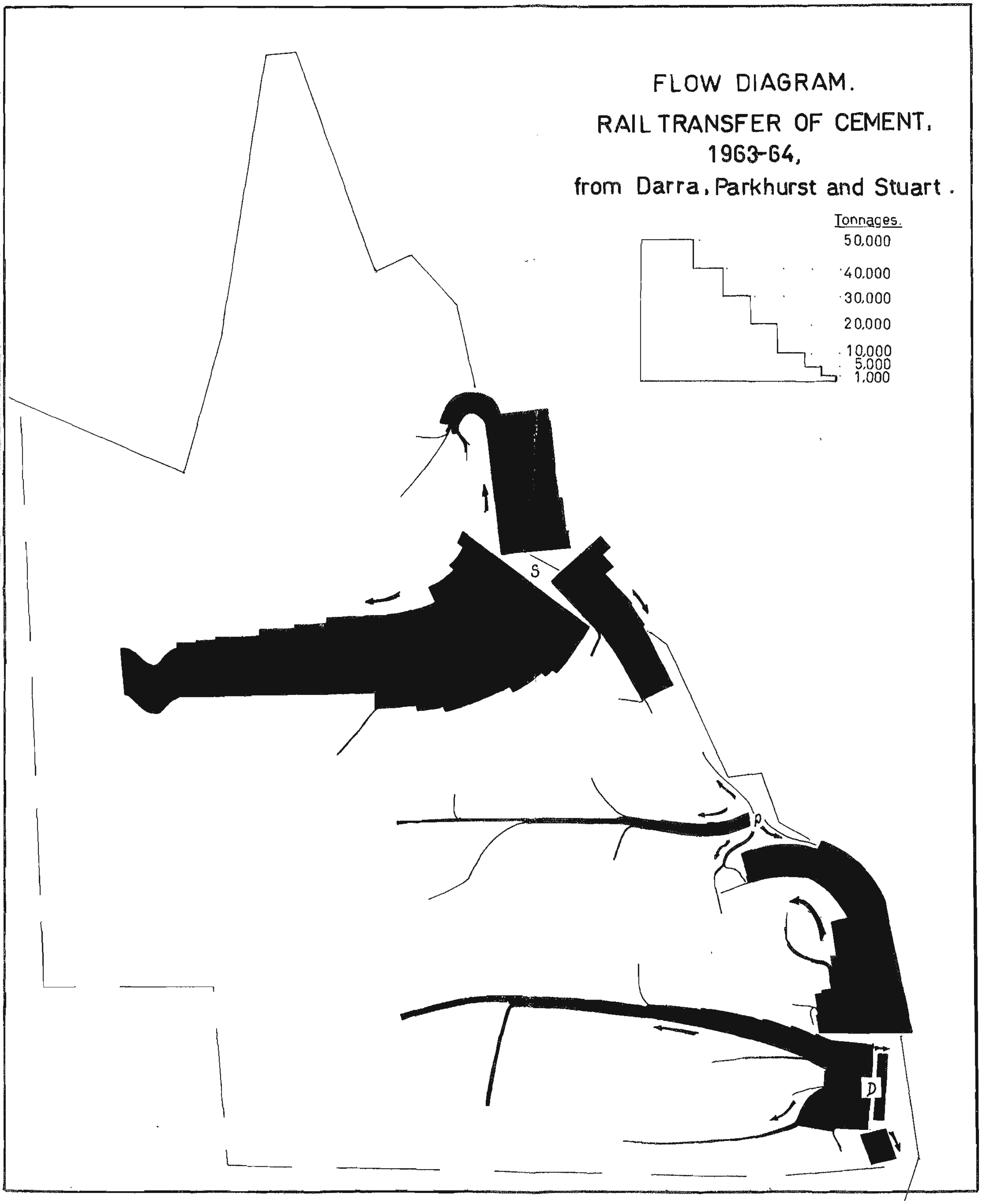
As a result the consignments along the western line from Townsville are greatly increased during the first two years of the period studied. Although it is fairly certain that almost all of the extra goods were consigned to the construction sites on the western line, some could have gone to any of the other stations to which consignments were made from Stuart. This means that the commodity flows originating at Stuart can not be regarded as reliable guides to the cement flows in 1963-64 or 1964-65. An indication of the reliability of the maps as portrayals of cement flows can best be summarized in the following table which shows consignments of cement and clinker as a percentage of total consignments.

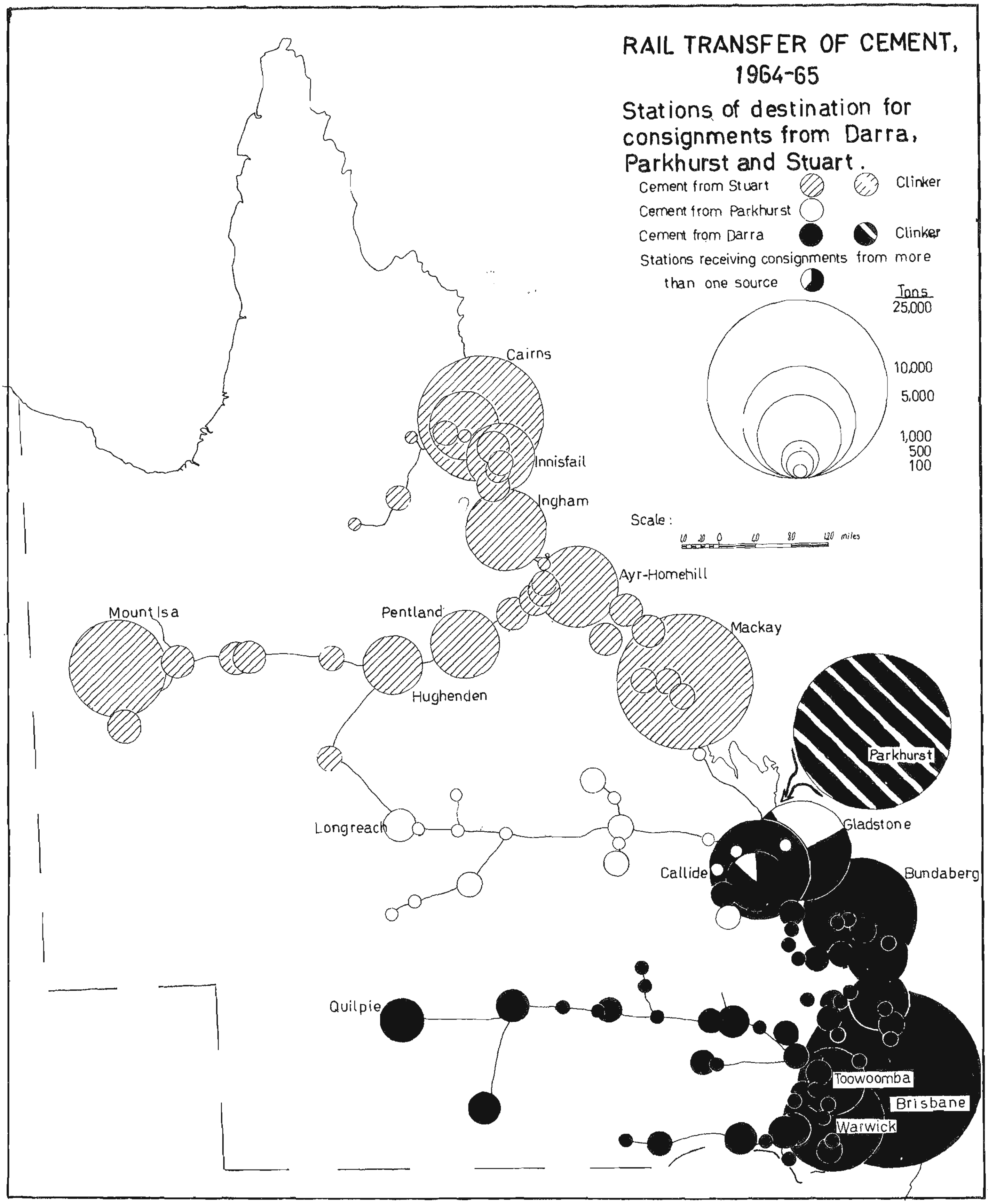
Reliability

	1963-64	1964-65	1965-66
Darra	97%	97%	97%
Parkhurst	100%	100%	100%
Stuart	61%	85%	97%

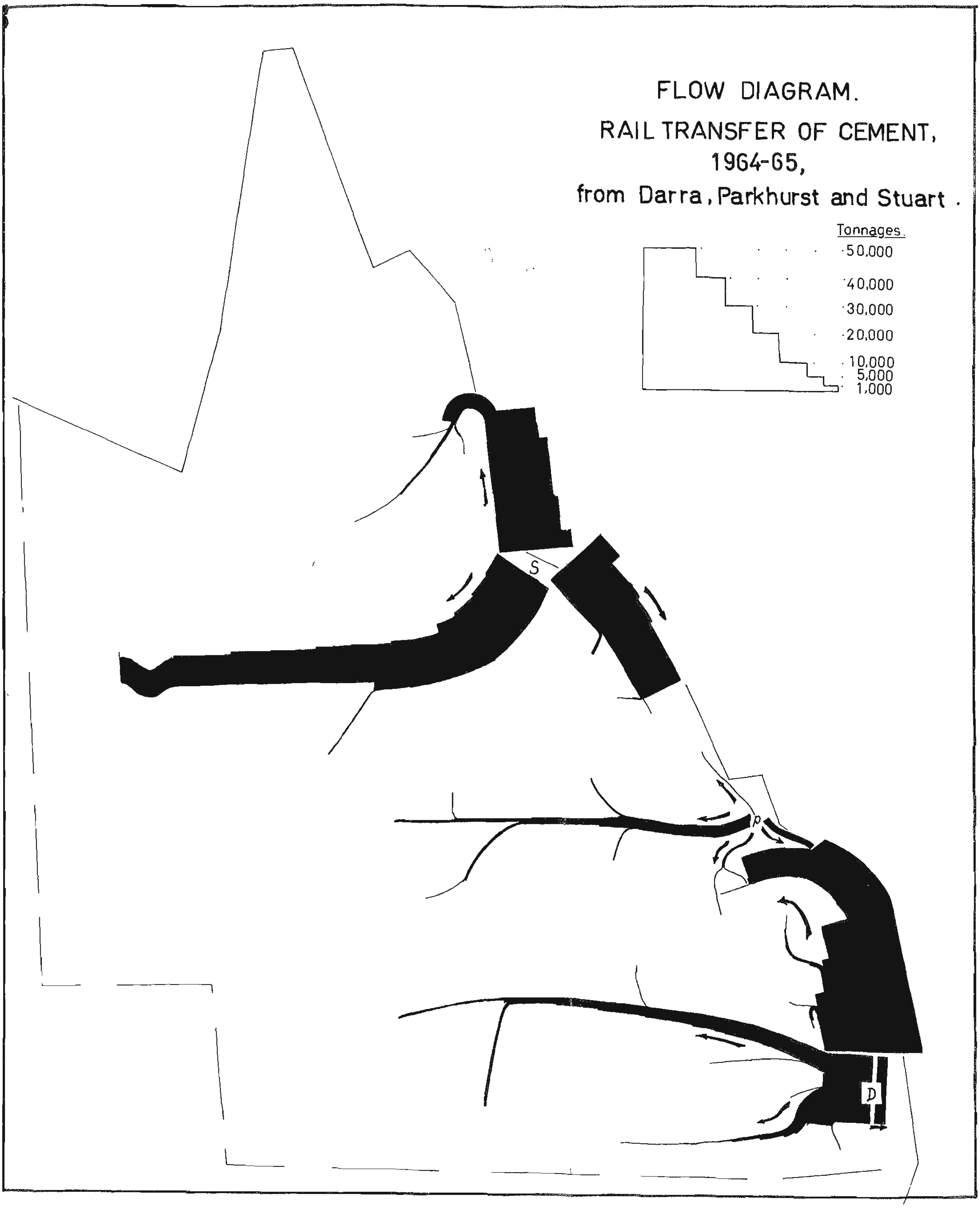
For this reason an "Apparent Consumption" map (See Chapter V, Section 6) was drawn for the year 1965-66 only.

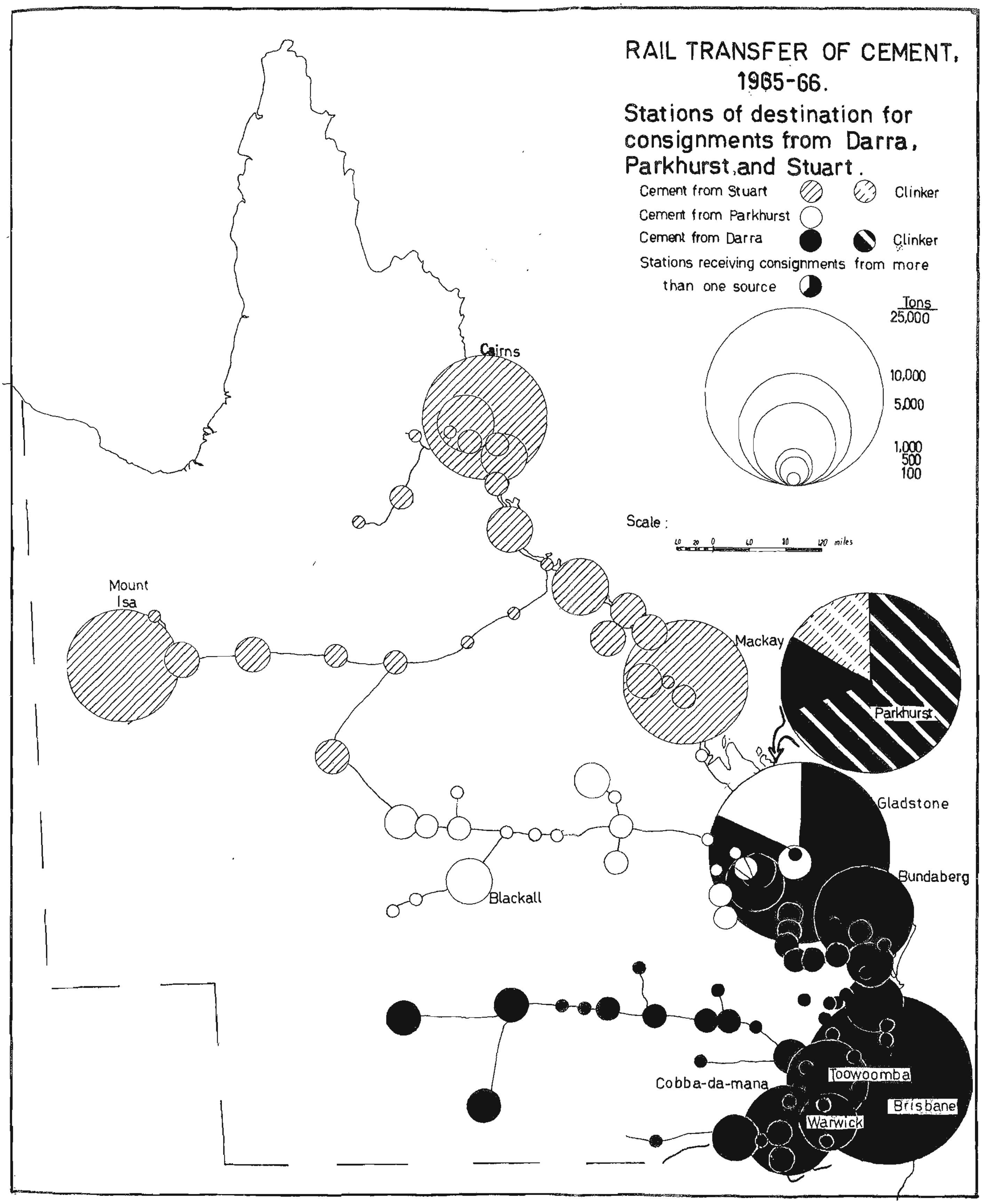

RAIL TRANSFER OF CEMENT, 1963-64.
Stations of destination for consignments from Darra, Parkhurst and Stuart.
Cement from Stuart
Clinker
Cement from Parkhurst
Cement from Darra
Clinker
Stations receiving consignments from more than one source
Tons
25,000
10,000
5,000
1,000
500
100
Scale:
40 20 0 40 80 120 miles
Cairns
Woodstock
Macrossan
Mount Isa
Hughenden
Mackay
Parkhurst
Longreach
Gladstone
Callide
Bundaberg
Quilpie
Brisbane
Southport
Warwick


FLOW DIAGRAM.
RAIL TRANSFER OF CEMENT,
1963-64,
from Darra, Parkhurst and Stuart.
Tonnages.
50,000
40,000
30,000
20,000
10,000
5,000
1,000
S
P
D

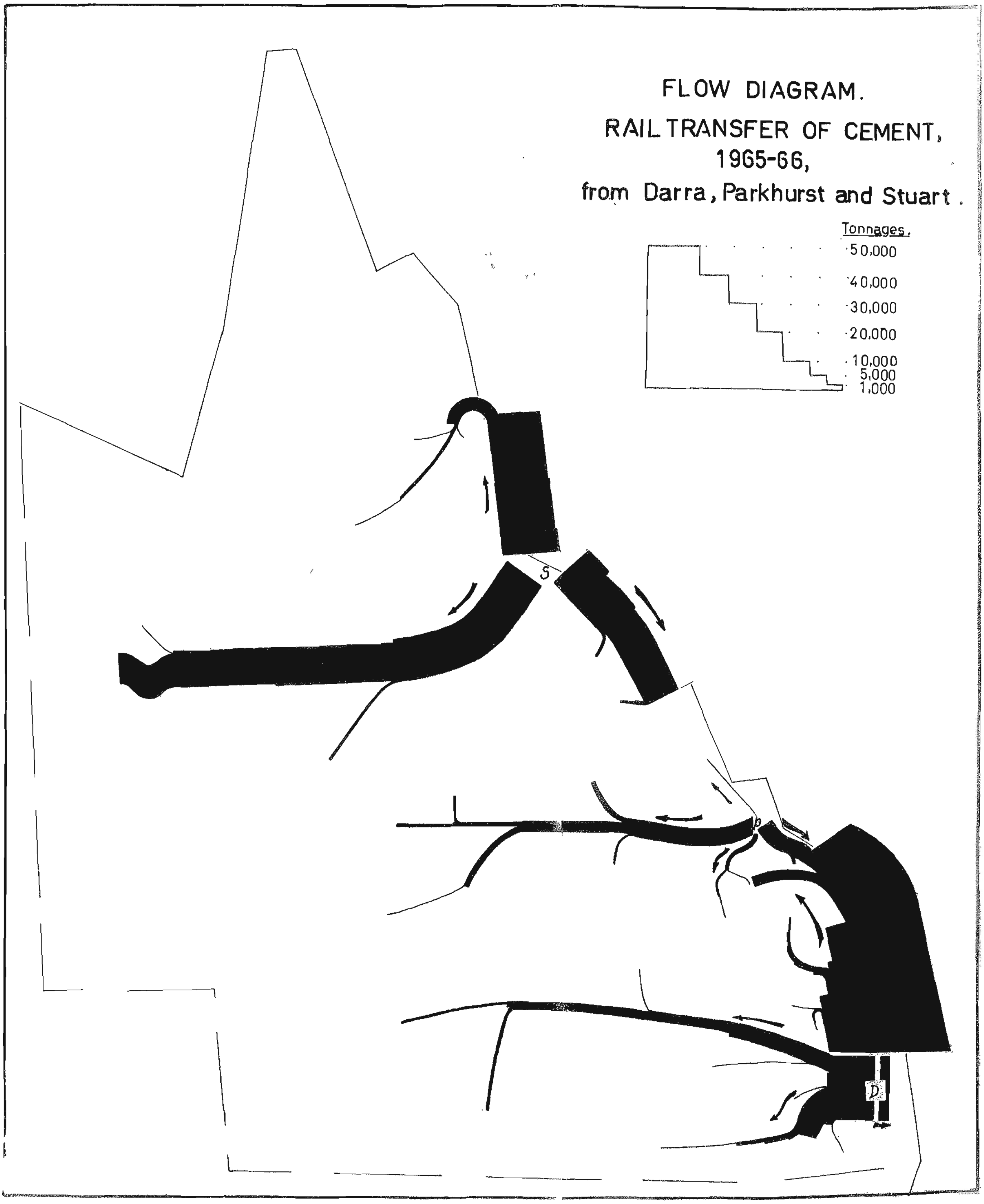


RAIL TRANSFER OF CEMENT, 1964-65
Stations of destination for consignments from Darra, Parkhurst and Stuart.
Cement from Stuart
Clinker
Cement from Parkhurst
Cement from Darra
Clinker
Stations receiving consignments from more than one source
Tons
25,000
10,000
5,000
1,000
500
100
Scale:
miles
Cairns
Innisfail
Ingham
Ayr-Homehill
Mackay
Mount Isa
Pentland
Hughenden
Parkhurst
Longreach
Gladstone
Callide
Bundaberg
Quilpie
Toowoomba
Brisbane
Warwick


FLOW DIAGRAM.
RAIL TRANSFER OF CEMENT,
1964-65,
from Darra, Parkhurst and Stuart.
Tonnages.
50,000
40,000
30,000
20,000
10,000
5,000
1,000
S
P
D



RAIL TRANSFER OF CEMENT, 1965-66.
Stations of destination for consignments from Darra, Parkhurst, and Stuart.
Cement from Stuart
Clinker
Cement from Parkhurst
Cement from Darra
Clinker
Stations receiving consignments from more than one source
Tons
25,000
10,000
5,000
1,000
500
100
Scale:
Cairns
Mount Isa
Mackay
Parkhurst
Gladstone
Bundaberg
Blackall
Cobba-da-mana
Toowoomba
Brisbane
Warwick


FLOW DIAGRAM.
RAIL TRANSFER OF CEMENT, 1965-66,
from Darra, Parkhurst and Stuart.
Tonnages.
50,000
40,000
30,000
20,000
10,000
5,000
1,000
S
P
D

APPENDIX 5

CALCULATION OF TRANSPORT INPUTS.

The purpose of this appendix is to support and amplify the argument of Chapter V Section 3 by providing data and calculations which by their nature were too bulky and digressive for inclusion in the main body of the argument.

As shown on pages 133-136, the location decision in 1914 was limited to choice between the Warwick district, the Maryborough district, the Brisbane area or to some intermediate points on the rail lines from these outer districts to Brisbane. In this analysis only the costs of rail transport can be considered, and these costs will be examined only for the transport of limestone, coal and cement.

The underlying assumptions of the analysis are :

(1) that the costs of moving these three materials are the major variables in the total transport costs;

(2) that all limestone or all coal will be drawn from a single source of that requirement;

(3) that all cement will be transported to Brisbane.

The basic sets of data for the analysis are:

(1) that 130 tons of limestone are required for the manufacture of 100 tons of cement;

(2) that 30 tons of coal are required for the manufacture of 100 tons of cement;

(3) that transport charges may be calculated from the following table based on the Q.G.R. Rate Book for 1914. (As the exact site is still undetermined by this analysis, the figures for distances are rounded to the nearest multiple of 5 miles).

FREIGHT COSTS (in pence per ton)

miles	coal or limestone	cement	miles	coal or limestone	cement
0-10	15	30	110	113	175
15	20	38	145	139	210
20	25	45	150	143	215
25	30	53	160	150	225
35	40	68	170	158	235
40	45	75	175	162	240
50	55	90	185	169	250
55	60	98	190	173	255
60	65	105	200	181	265
70	75	120	210	186	272
75	80	128	215	188	276
100	105	165	225	193	283

Calculations of the costs of the transport inputs have been made for three major limestone sources, Gore (west of Warwick), Marule and Biggenden (in the Maryborough district). Calculations were also made for two of the closer but much smaller deposits, Silverwood (south of Warwick) and Tamaree (north of Gympie). In each case calculations have been made in the following form :

	Transport costs (in pence per 100 tons of cement)		
Location of plant	Limestone tonnage	x Freight = a	) a + b
	Coal tonnage	x Freight = b	)
	Cement	x Freight = c	
	Cost	a + b + c	

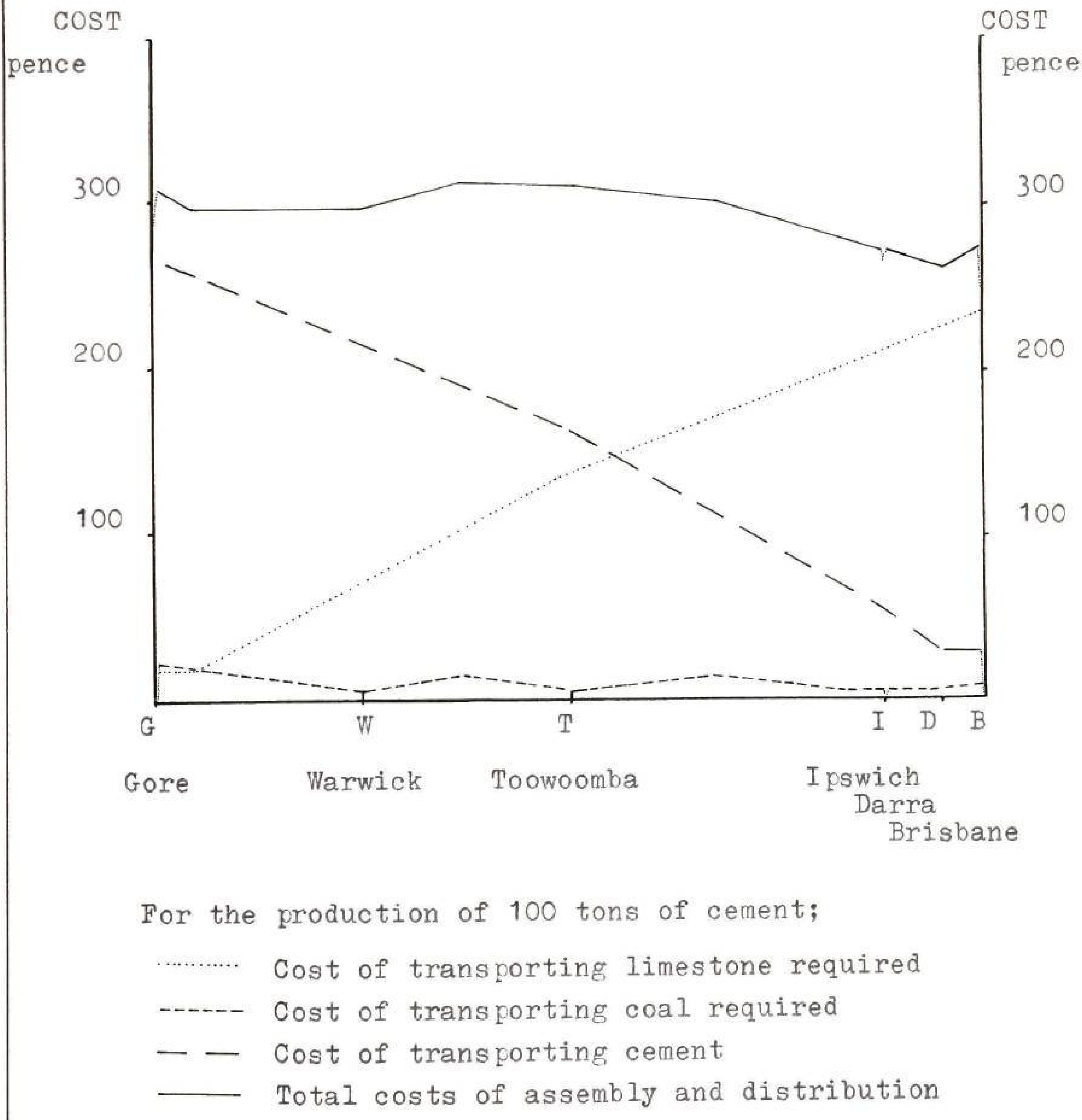
1. Using Gore limestone,

Transport costs (in pence per 100 tons of cement):

Gore	130	x	0	=	0	2,250
(Tannymorel	30	x	75	=	2,250	
coal)	100	x	265	=	26,500	
					28,750	
Warwick	130	x	55	=	7,150	7,900
(Tannymorel	30	x	25	=	750	
coal)	100	x	215	=	21,500	
					29,400	
Toowoomba	130	x	105	=	13,650	14,400
(Oakey	30	x	25	=	750	
coal)	100	x	165	=	16,500	
					30,900	
Ipswich (1)	130	x	162	=	21,060	21,060
(no freight	30	x	0	=	0	
on coal)	100	x	53	=	5,300	
					26,360	
Ipswich (2)	130	x	162	=	21,060	21,510
(some	30	x	15	=	450	
freight on	100	x	53	=	5,300	
coal)					26,810	
Darra	130	x	173	=	22,490	23,090
(Ipswich	30	x	20	=	600	
coal)	100	x	30	=	3,000	
					26,090	
Brisbane	130	x	181	=	23,530	24,430
(Ipswich	30	x	30	=	900	
coal)	100	x	0	=	0	
					24,430	

The exceptional purity of the Gore limestone allowed as little as 120 tons to be used per 100 tons of cement. This does not change the calculations for location at Gore but reduces the figure for Darra to 24,360 and for Brisbane to 22,620.

The level of costs of the major transport inputs for locations between Gore and Brisbane.



2. Using Marule limestone,

Transport costs (in pence per 100 tons of cement) :

Marule (Howard coal)	130	x	0	=	0	)	1,350
	30	x	45	=	1,350	)	
	100	x	283	=	28,300		
					29,650		
Burrum River (Howard coal)	130	x	45	=	5,850	)	5,850
	30	x	0	=	0	)	
	100	x	250	=	25,000		
					30,850		
Aldershot (Aldershot coal)	130	x	60	=	7,800	)	7,800
	30	x	0	=	0	)	
	100	x	240	=	24,000		
					31,800		
Zillmere (Ipswich coal)	130	x	188	=	24,440	)	25,640
	30	x	40	=	1,200	)	
	100	x	30	=	3,000		
					28,640		
Brisbane (Ipswich coal)	130	x	193	=	25,090	)	25,990
	30	x	30	=	900	)	
	100	x	0	=	0		
					25,990		

As noted in the text, location at Marule has the lowest costs for assembly of coal and limestone, but the costs of transporting the cement to Brisbane put it at a serious disadvantage.

The Marule limestone was both further from Brisbane and less pure than the Gore limestone. Not only did it have over 10% silica but its magnesia content was high.

The suggested Zillmere location is a convenient designation for location at the end of the terminal block zone 10 miles north of Brisbane in the same way as Darra is 10 miles west.

3. Using Biggenden limestone,

Transport costs (in pence per 100 tons of cement) :

Biggenden (Aldershot coal)	130	x	0	=	0	)	2,400
	30	x	80	=	2,400	)	
	100	x	272	=	27,200		
					29,600		
Aldershot (Aldershot coal)	130	x	80	=	10,400	)	10,400
	30	x	0	=	0	)	
	100	x	240	=	24,000		
					34,400		
Mungar (Aldershot coal)	130	x	60	=	7,800	)	8,550
	30	x	25	=	750	)	
	100	x	215	=	21,500		
					30,050		
Zillmere (Ipswich coal	130	x	181	=	23,530	)	24,730
	30	x	40	=	1,200	)	
	100	x	30	=	3,000		
					27,730		
Brisbane (Ipswich coal)	130	x	188	=	24,440	)	24,440
	30	x	30	=	900	)	
	100	x	0	=	0		
					25,340		

The Biggenden limestone was also less pure than that at Gore but calculations for Biggenden make it unnecessary to consider the use of Mundubbera limestone. This latter, which was of a quality comparable to that at Gore, was more than 50 miles further away from Brisbane beyond Biggenden. (Mundubbera is 256 miles from Brisbane.)

4. Using Silverwood limestone,
Transport costs (in pence per 100 tons of cement) :

Silverwood	130	x	0	=	0	)	1,350
	30	x	45	=	1,350	)	
	100	x	235	=	23,500		
					24,850		
Darra	130	x	150	=	19,500	)	20,100
	30	x	20	=	600	)	
	100	x	30	=	3,000		
					23,100		
Brisbane	130	x	158	=	20,540	)	21,440
	30	x	30	=	900	)	
	100	x	0	=	0		
					21,440		

It will be seen that these values are less than those calculated for Gore limestone, but as has been noted in the text these deposits were smaller than those at Gore. Apparently they were not chosen for this reason.

As the Gore calculations show the Darra and Brisbane locations involve lower costs than Warwick, Toowoomba or Ipswich locations, these calculations have been omitted.

5. Using Tamaree limestone,

Transport costs (in pence per 100 tons of cement) :

Tamaree (Aldershot coal)	130	x	0	=	0	)	1,950
	30	x	65	=	1,950	)	
	100	x	175	=	17,500		
					19,450		
Zillmere (Ipswich coal)	130	x	105	=	13,650	)	14,850
	30	x	40	=	1,200	)	
	100	x	30	=	3,000		
					17,850		
Brisbane (Ipswich coal)	130	x	113	=	14,690	)	15,590
	30	x	30	=	900	)	
	100	x	0	=	0		
					15,590		
Darra (Ipswich coal)	130	x	121	=	15,730	)	16,330
	30	x	20	=	600	)	
	100	x	30	=	3,000		
					19,330		

These values are by far the lowest of any in this analysis. The small size of the suitable grade deposit apparently ruled it out also.

These calculations have been based on the assumption that all the limestone would come from a single source. What is difficult to understand is why the Q.C. & L. Company did not obtain <u>some</u> of their limestone from these two smaller sources even when it had decided to secure the large supplies at Gore and a site at Darra. The cost of <u>establishing</u> a quarry or quarries at Silverwood would have added to the costs of winning the limestone but the Tamaree limestone was already being worked. The cost saving of using Tamaree limestone at the Darra works would have been £6,000 per annum for the intended production of 30,000 tons of cement unless the quarrying costs of the smaller deposit were greater than those for the large pure supplies at Gore.